Heating and Piping Contractors National Association

Engineering Standards

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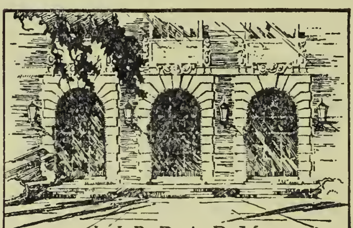


Heating and Piping Contractors National Association

Engineering Standards

DEVELOPED BY THE

COMMITTEE ON STANDARDIZATION

OF THE

HEATING AND PIPING CONTRACTORS

NATIONAL ASSOCIATION

50 UNION SQUARE NEW YORK, N. Y.

PART I
FIGURING RADIATION

Page I. 19th line insert after word "units" the words "per square foot".

Page II. 41st line "1.5 units" should read "1.55 units".

Page III. 1st line "2 lbs." should read "1 lb." and "220°" should read "215°".

3rd line should read—(215-70) x 1.55 = 225 heat units per sq. ft. of radiation.

18th line should read—

$$\frac{1.1 \times 70}{(170\text{-}70) \times 1.55} = .497 \text{ sq. ft. of 3 column } 38'' \text{ radiation.}$$

Page VI. 43rd line "+10°" should read "+5°".

45th line "33 1/3%" should read "25%".

Page VII. 2nd line "15%" should read "10%".

4th line "25%" should read "20%".

Issued July 1925

FOREWORD

ALL rules for figuring radiation are based on the heat required to make up the losses due to the transfer of heat through walls, windows, floors, ceilings and roofs; and the heat required to bring the air that leaks in through cracks from the outside temperature to the temperature desired in the room.

No matter what the rule used has looked like, if it had any reason at all for its being used, it was based on a scientific law of heat transfer. Every material has a definite rate of transfer or loss, depending on the kind of material entering into its manufacture, and dependent on the temperature on both sides; in this case, the temperature desired in the room and the temperature outside. This transfer is also dependent on the velocity of the wind, and on the moisture in the air. The leakage of air is dependent on construction, and on wind velocity, pressure and direction.

All of these heat changes have always been measured in British Thermal Units called B.t.u.s and the B.t.u. method of figuring radiation is simply a case of adding these losses together and dividing them by the heat units given out by the radiator. When one has used the Mill's formula, or Carpenter's Rule, or a 4, 4, 4 rule, or any one of the multitude of rules looking something like these rules, he has used a B.t.u. method. It may have been concealed in a short hand method devised by the author of the rule to fit his particular conditions.

These rules have varied so much, the kinds of materials entering into construction have become so varied and complicated, the conditions in different sections of the country are so widely different, that the Committee on Standardization of your Association was given the task of examining the existing rules, the existing constants, etc., and formulating new factors from which all the members could safely and consistently figure the radiation required.

In order to explain their task, let us take one of the well-known old formulas for figuring radiation, such as Carpenter's rule.

$$\left(G + \frac{W}{4} + .02\,NC\right) \times (T_i - T_o)$$

Where G = sq. ft. of glass
W = sq. ft. of exposed wall
$.02$ = specific heat of air
N = number of air changes per hour and C the cubic contents of the room.
$(T_i - T_o)$ = difference between the indoor and outdoor temperature.

An examination of this formula will show how incorrect it is for our present conditions. It can be seen from the formula that the coefficient of transmission for glass was always 1, irrespective of the kind of window; that the coefficient of transmission for wall was always .25 irrespective of the kind of wall; .02 which is the specific heat of air, is more properly .018; and that the number of air changes represented by N was purely guess work and that this was the only variable factor in the whole formula and was supposed to take care of exposures, window construction, inleakage and all the other factors that might in any way influence the amount of heat required. Other formulas followed along similar lines. This showed the necessity for providing a method of figuring radiation that would take into consideration the various types of construction and the differing conditions.

First a study was made of plain single glass, just glass, not the air that came through windows—but how good an insulator glass is. Each of twenty authorities gives a different value, and each has different values for different conditions,—wet weather, windy weather, or both. It is never very wet when very cold, so that factor may be eliminated. It seemed that the conditions on which the most reliable figures could be obtained were for dry air with a 15 mile wind; and for single glass the best authorities to date have figured that one square foot of glass transmits 1.1 heat units for each degree difference of temperature between the air on one side and the air on the other side, with a 15 mile wind velocity. In other words, if a room temperature of 70° is required with 0° outside and a 15 mile wind, it is necessary to take care of 1.1 × 70 equals 77 heat units every hour for each square foot of glass, and as each square foot of 38″, 3 column radiation gives out 1.5 units for every degree difference between the temperature in the radiator and the temperature of the room,

it will give, with 2 lbs. steam pressure,—220° in the radiator and 70° in the room, therefore

$(220 - 70) \times 1.5 = 225$ heat units per sq. ft. of radiation.

So for each square foot of glass under these conditions, 77/225 or about 1/3 square foot of 38″, 3 column radiation is required. This method shows the correct procedure. In locations where the difference in temperature between outside and inside is only 60°, multiply the 1.1 by 60 instead of 70; and similarly, if a room temperature of 60° is required.

If hot water is the heating medium, we select the mean temperature in the radiator to determine the square feet of radiation required. If the piping system is designed for a 20° drop the mean temperature in the radiator, which is the temperature we use, will be 10° less than the maximum. As the maximum is usually 180° the mean temperature in the radiator would be taken as 170°. Then, with a 170° mean temperature, each square foot of single glass would require for 70° difference

$$\frac{1.1 \times 70}{(170-70) \times 1.5} = .513 \text{ sq. ft. of 3 column 38'' radiation.}$$

With the rules most of us have been using, we never would have known how to find the difference in radiation required for these different conditions.

When by exhaustive examination the transmission coefficient for glass had been determined, it was necessary to study double glass and the effect of air spaces, skylights and wire glass; and the further one departed from simple materials, the less there seemed to be known about the subject. It is thought that the factors finally selected are the best for the heating conditions encountered and the best that our investigations have disclosed to be in existence both in this and foreign countries.

In addition to glass, the heat transmission through walls was considered and only a study of this subject will disclose the enormous variety of materials that are used in construction and how many combinations of these materials there are. When the rules commonly used were made, brick was the usual construction and the formulas were based on this material.

Since that period a number of research laboratories and scientific schools have determined the coefficients of transmission of quite a number of simple materials. Their results were investigated and the most accurately determined coefficients selected. From these coefficients of transmission of the simple materials, the coefficients of the compound materials were determined by the reciprocal method, the results from which at times were slightly modified to make the coefficients in the following tables.

The formula for obtaining a coefficient by the reciprocal method is

$$K = \cfrac{1}{\frac{1}{K_1} + \frac{1}{K_2} + \frac{1}{K_3} + \dots\dots \frac{1}{K_n}}$$

Factors for most of the usual types of construction are given in the following tables.

Note that floors and ceiling factors are different from those of walls, due to the fact that heat travels upward and there is a difference between the temperature of the air at the floor and that at the ceiling. The square feet of radiation for walls, floors and ceilings, doors, etc., are calculated in the same manner as glass, that is, so many square feet times its factor K times the difference in temperature (desired) inside the room and the outside temperature; this divided by the heat units given out by the radiator per square foot at the room temperature, gives the radiation for this particular part.

It is from this point on that the guessing of heating contractors began. They knew that if they only took these two factors, wall and glass, into consideration, they would inevitably get into trouble, so they said: "There's an air change; fresh air blows in through cracks, how can I take care of this; walls are colder too on the windy side of the house. Well, I guess this room has one air change an hour or two or one and a half or something, and to make myself safe, I'll add 10% or 20% or 30% to the whole thing to make sure."

In order to eliminate the guess work from this part of the calculations, we investigated the various methods of arriving at the air inleakage or air changes in different types of rooms and in rooms of different exposures. It is obvious that the only air that could leak into the room, assuming normal construction, was through the window cracks or through doors, and investigation showed that this idea was not new but that it had been tested by various authorities and that there is some considerable data on this subject, although the investigations are still being carried on in a great many places. The tests that had been made were sufficiently reliable to show that the amount of air change in the room was practically not dependent upon the size of the room at all, but on the amount of crack area around and across the window and that leakage or inleakage varied with the type of sash construction; being different for wood sash, metal sash, fenestra, stationary sash, French windows, in very wide ranges. However, there was enough similarity between all the tests that had been made to warrant the assumption of a definite amount of inleakage for each type, which we have incorporated into our

calculations, and which is infinitely closer to the truth than the average guess that all of us have used for so many years.

It was very easy to determine the amount of radiation required to take care of the air that would leak into the room in an hour, because the theory of the heating of air is an old and established scientific calculation entailing no difficulty. In other words, it is well-known that one heat unit will raise one cubic foot of air at the temperature that is customary in heating, 55.2°, or that one heat unit will raise 55.2 cubic feet of air 1° per hour. Therefore, if 100 cubic feet of air leaks into a room and it is desired to raise this 100 cubic feet of air from its temperature outside (assumed to be zero) to the 70° to which the room is to be warmed, multiply the number of cubic feet of air by 70 and divide by 55.2 or multiply by .018. This gives the total number of heat units required for the air inleakage, and this, divided by the number of heat units given off by a square foot of radiation gives the additional amount of radiation required by air changes.

In working on air changes due to inleakage, the most interesting part of the investigation developed, i. e. that the direction and velocity of the wind has a marked effect on the amount of radiation required to heat a building. In fact, it developed that the reason our buildings were usually not overheated even in days of moderate temperature, and by moderate temperature we mean around 15° to 20° above the outdoor temperature for which the system was designed, was due to the fact that one mile of wind velocity was practically equivalent to 1° drop in temperature. In other words, for ease of calculation, a 15 mile wind with a 15° temperature is equivalent to 0° with no wind.

It also developed that all the factors used in calculating radiation, that is, glass and wall and inleakage, were all based on a wind factor; that when 1.1 heat units per square foot of glass was used as a factor for single glass, it was the transmission with a 15 mile wind; and it was only due to the foresight or luck of the early investigators that the heating systems that we installed did not get us into an infinite amount of trouble. It is for the reason that the equivalent temperature is often far below zero due to high wind velocities that the exposure factors of 5 to 50 have been added as a regular thing to all of our calculations for radiation. In Carpenter's formula allowance for this condition was made by increasing the number of air changes but did not consider the effect of the wind on the wall and glass.

After this condition was discovered, it became necessary to find the prevailing temperatures in the various sections of the country, and the prevailing wind directions and wind velocities with these temperatures. In order to accomplish this it was necessary to obtain from the local Weather Bureaus and from the United

States Weather Bureau hourly records of temperature, wind direction and wind velocity for various cities plotted over the whole country. A number of representative cities were selected and the months of January and February, the coldest months for an average three year period, actually years 1918, 1919 and 1920. This work required the analyzing of nearly 90,000 records and the results are extremely interesting. Every reading was reduced to an equivalent factor, that is, if on the north side there was a temperature at a certain hour of 10° with a wind velocity of 15 miles an hour, the temperature was plotted as north minus 5°, then, by eliminating from this exposure the isolated and scattered exceptional conditions, we were able to get a condition that would prevail for a long enough period to influence the heating, taking into account the fact that there is always a time element in heating and that a particularly severe condition for only a short period of time, say 1 or 2 hours, should not be calculated in figuring the radiation required for any building.

One of the other interesting facts that developed in the investigation of this subject, was that the blanket of air propelled against a building was of such magnitude and volume that its effect on inleakage was the same irrespective of its angle of direction, that is, a northwest wind of certain velocity had as much effect on inleakage and transmission on the north side of the building as though the wind direction had been due north and of equal velocity. We therefore took the equivalent temperature as applying to three out of eight directions. For example, in arriving at the exposure factor for north, the factors for northwest and northeast were considered and the highest of the three was used, etc. In this way the maximum number of exposure constants required would be six, but in practically every case it worked down to three and in exceptional cases four.

It is interesting to note that the northern exposure is not necessarily the worst. The surrounding profile of the country or the proximity of bodies of water seems to affect these conditions.

The other interesting point is that the base temperature we have been accustomed to use, that is, 0°, in most cases is erroneous when it is taken into consideration that all the factors of transmission and infiltration are based on a 15 mile an hour wind velocity and that this factor must be deducted in order to get a true base condition. For instance, Chicago which has always been figured with a –10° base temperature; under the new method of allowance for the factors already included in all our coefficients has a base temperature of +10° and, surprising as it may seem, west is the worst exposure and affects southwest and northwest to the same extent necessitating the addition of 33 1/3% to wall and glass and infiltration on these points of the compass. North-

east and east and southeast require no additional radiation beyond the basic calculations, whereas south requires 15% to be added to compensate for severe southwest winds; likewise north requires the addition of 25% to compensate for severe northwest winds.

The formula, in which the coefficient and factors presented in this handbook are to be used, is

$$\frac{(W + G + I)\ (T_i - T_o)\ E + O\ (T_i - T_a)}{R} = \text{sq. ft. rad.}$$

Where

W = Net area in square feet of exposed wall $\times$ K

G = Area in sq. ft. of full frame opening of windows or doors $\times$ K

O = Net area in square feet of roof, floor or any exposure not included above $\times$ K

I = Lineal feet of window or door crack $\times$ infiltration in cu. ft. per hour per lineal foot of crack as shown in tables $\times$ .018

K is the coefficient of transmission as shown in the tables for the particular material.

E is the exposure factor as shown in the tables for the particular locality and direction of exposure.

T_i is the desired room temperature.

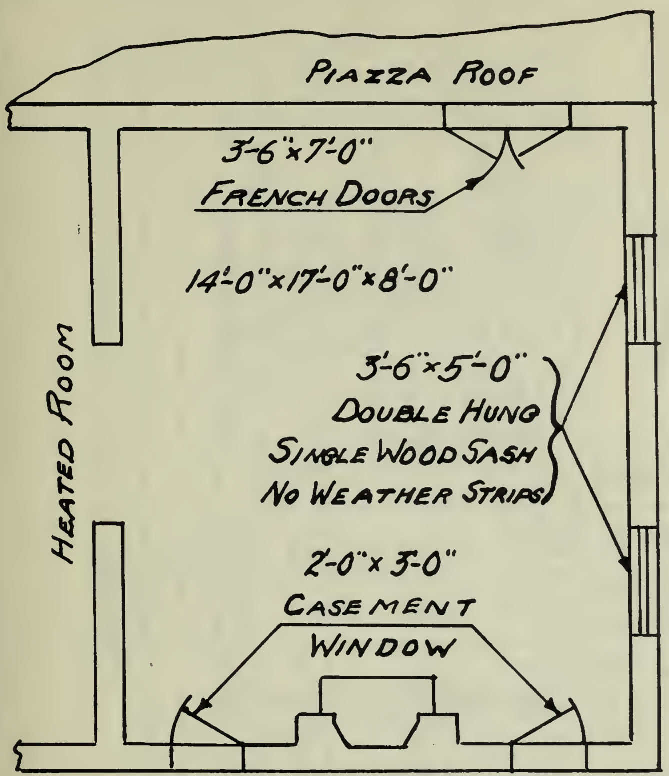
T_o is the base temperature as shown in the tables for the particular locality.

T_a is the temperature of adjacent spaces of a different temperature from T_i.

R is the number of heat units emitted per hour by one square foot of radiation as shown in the tables.

The application of the formula is shown on pages VIII and IX.

[illegible]



PLAN OF SECOND FLOOR ROOM WITH 8" BRICK WALL, FURRING, LATH AND PLASTER, LATH AND PLASTER CEILING WITH UNHEATED ROOF SPACE ABOVE.

LOCATION — CHICAGO, ILL.

(FOR CALCULATIONS SEE PAGE IX)

NAME	MATERIAL	EXPOSURE	WIDTH (FT.)	HEIGHT OR LENGTH (FT.)	AREA OR LINEAL FT. CRACK NET	FACTOR	TEMPERATURE DIFFERENCE	NET B.T.U. REQUIRED	EXPOSURE FACTOR	TOTAL B.T.U. REQUIRED	RADIATOR FACTOR	TOTAL RADIATION ⌗
GLASS	FRENCH DOOR	S	3½	7	24½	1.1	60°	1617	1.15	1860		
WALL	8" BRICK F. L. AND P.	S	14	8	87½	.27	60°	1418	1.15	1631		
INFILTRATION	FRENCH DOOR	S			28	1.8	60°	3024	1.15	3478		
GLASS	WINDOW	W	6	5	30	1.1	60°	1980	1.33	2640		
WALL	8" BRICK F. L. AND P.	W	17	8	106	.27	60°	1717	1.33	2289		
INFILTRATION	DOUBLE HUNG WINDOW	W			38	.9	60°	2052	1.33	2735		
GLASS	WINDOW	N	6	2	12	1.1	60°	792	1.25	990		
WALL	8" BRICK F. L. AND P.	N	14	8	100	.27	60°	1620	1.25	2025		
INFILTRATION	CASEMENT	N			20	1.8	60°	2160	1.25	2700		
CEILING	L AND P AND ROOF SPACE	–	14	17	238	.49	40°	4665	–	4665		
										25013	225	111

NOTE: IF FRENCH DOOR, AND WINDOWS WERE METAL WEATHER STRIPPED THE RADIATION REQUIRED WOULD BE 91 ⌗.

SINGLE WINDOW

T	T_1	K		
		1.1		

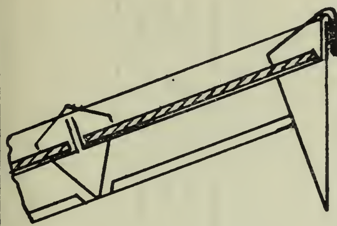
SINGLE WINDOW WITH DOUBLE GLASS

T	T_1	K		
		0.6		

DOUBLE WINDOW

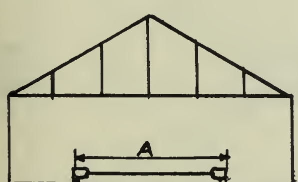
T	T_1	K		
		0.6		

SINGLE LIGHT



T	T_1	K		
		1.3		

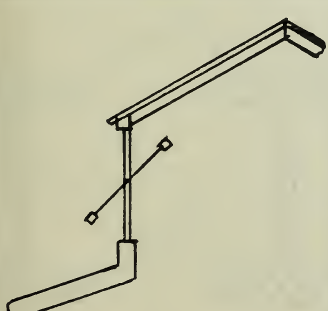
CEILING LIGHT



A = AREA OF CEILING LIGHT

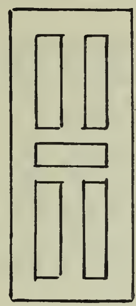
T	T_1	K		
		0.8		

SINGLE MONITOR



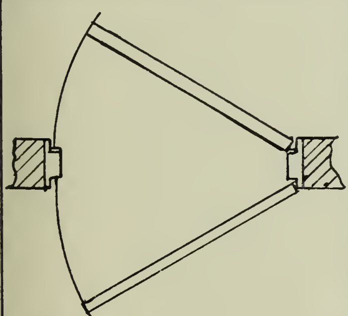
T	T_1	K		
		1.3		

SINGLE DOOR



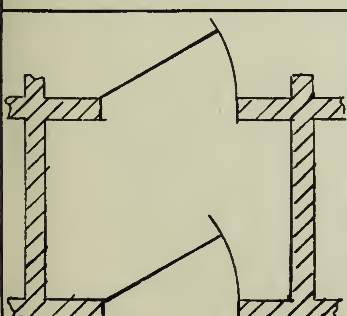
T	T_1	K		
		1.1		

DOUBLE DOOR



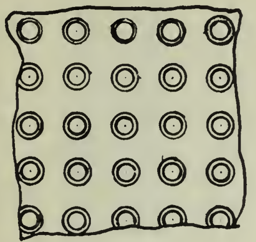
T	T_1	K		
		0.6		

INNER VESTIBULE DOOR



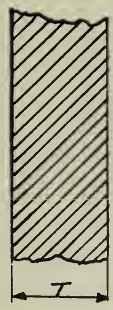
T	T_1	K		
		0.6		

IRON OR CEMENT VAULT GLASS



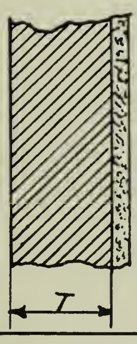
T	T_1	K		
		1.25		

NO LATH OR PLASTER



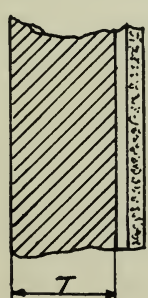
T	T_1	K		
4"		.60		
8"		.42		
12"		.32		
16"		.26		
18"		.25		
20"		.23		
24"		.20		

PLASTER ONE SIDE ONLY



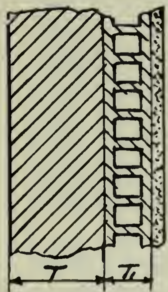
T	T_1	K		
4"		.49		
8"		.38		
12"		.29		
16"		.25		
18"		.24		
20"		.22		
24"		.19		

FURRING LATH AND PLASTER



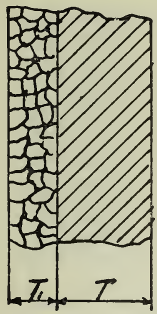
T	T_1	K		
4"		.33		
8"		.27		
12"		.23		
16"		.21		
18"		.20		
20"		.19		
24"		.16		

BRICK, HOLLOW TILE, AND PLASTER ONE SIDE



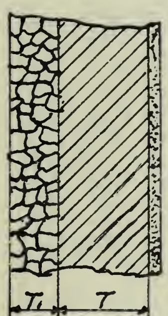
T	T_1	K		
4"	4"	.30		
8"	4"	.26		
12"	4"	.22		
16"	4"	.20		
20"	4"	.18		
24"	4"	.15		

PLAIN WITH SANDSTONE FACE



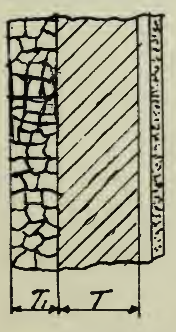
T	T_1	K		
4"	4"	.41		
8"	4"	.34		
12"	4"	.28		
16"	4"	.23		
20"	4"	.19		
24"	4"	.17		
28"	4"	.15		

PLASTERED



T	T_1	K		
4"	8"	.35		
8"	8"	.29		
12"	8"	.24		
16"	8"	.20		
20"	8"	.18		
24"	8"	.16		
28"	8"	.14		

FURRED AND PLASTERED

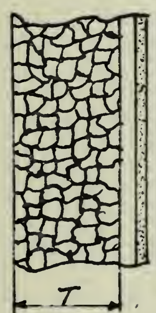


T	T_1	K		
4"	12"	.30		
8"	12"	.25		
12"	12"	.21		
16"	12"	.19		
20"	12"	.17		
24"	12"	.15		
28"	12"	.13		

PLAIN SANDSTONE, GRANITE OR MARBLE

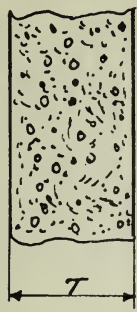
T	T_1	K		
8"		.60		
12"		.48		
16"		.41		
20"		.37		
24"		.33		
28"		.29		
30"		.28		

SANDSTONE, FUR, LATH AND PLASTER



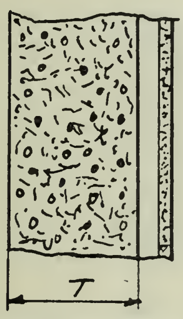
T	T_1	K		
8"		.50		
12"		.40		
16"		.34		
18"		.32		
20"		.31		
24"		.28		
28"		.25		

PLAIN LIMESTONE



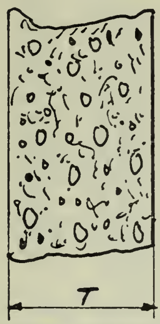
T	T_1	K		
8"		.63		
12"		.51		
16"		.43		
18"		.41		
20"		.39		
24"		.35		
28"		.31		

LIMESTONE, FUR, LATH AND PLASTER



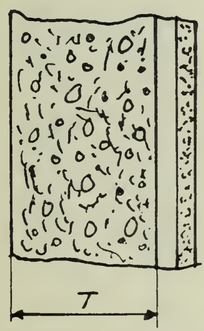
T	T_1	K		
12"		.43		
16"		.36		
18"		.34		
20"		.32		
24"		.29		
28"		.27		
30"		.25		

CONCRETE



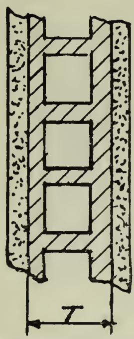
T	T_1	K		
8"		.60		
12"		.48		
16"		.41		
20"		.37		
24"		.33		
28"		.29		
30"		.28		

CONCRETE, FUR, LATH AND PLASTER



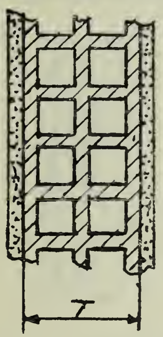
T	T_1	K		
8"		.50		
12"		.40		
16"		.34		
18"		.32		
20"		.31		
24"		.28		
28"		.25		

TILE – STUCCO OUTSIDE – PLASTER INSIDE



T	T_1	K		
4"		.40		

TILE – STUCCO OUTSIDE – PLASTER INSIDE



T	T_1	K		
8"		.31		
12"		.26		

FRAME & STUCCO CONSTRUCTION

	CONSTANTS			
	SAME	AS		
	CLAPBOARD WALL			
	PAGES 12-13-14			

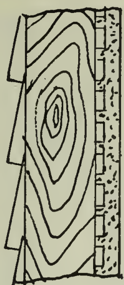
CLAPBOARDS ON STUDDING

T	T_1	K		
		.70		

CLAPBOARDS AND PAPER ON STUDDING

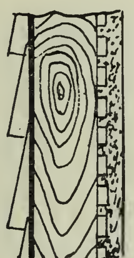
T	T_1	K		
		.48		

CLAPBOARDS, STUDDING, LATH AND PLASTER



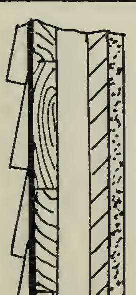
T	T_1	K		
		.45		

CLAPBOARDS, PAPER, STUDDING, LATH AND PLASTER



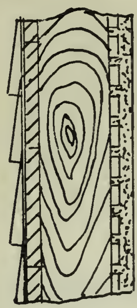
T	T_1	K		
		.31		

CLAPBOARDS, PAPER, SHEATHING, BACK PLASTER, L. AND P.



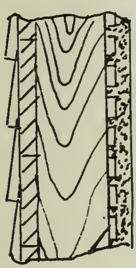
T	T_1	K		
		.21		

CLAPBOARDS, PAPER, SHEATHING, STUDDING, L. AND P.



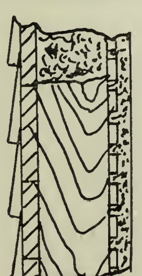
T	T_1	K		
		.24		

CLAPBOARDS, SHEATHING STUDDING, L. AND P.



T	T_1	K		
		.29		

CLAPBOARDS, SHEATHING, SAWDUST, L. AND P.



T	T_1	K		
		.15		

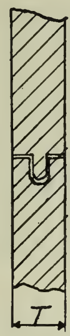
UNLINED CORRUGATED IRON

	T	T_1	K	D	M
			1.50		
AREA IS PROJECTED AREA NOT CORRUGATED AREA					

SHEET METAL, SIDING UNLINED

	T	T_1	K		
			1.20		

PLAIN TONGUE AND GROOVED BOARD

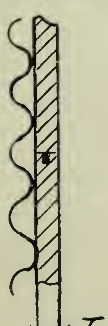


T	T_1	K		
1"		.65		

CORRUGATED IRON, T. AND G. BOARDS

T	T_1	K		
1"		.60		

CORRUGATED IRON, PAPER, T. AND G. BOARDS

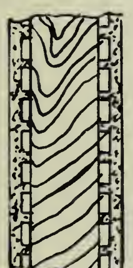


T	T_1	K		
1"		.56		

STUD PARTITION. L. AND P., ONE SIDE

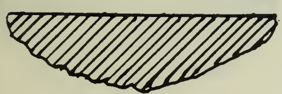
T	T_1	K		
		.60		

STUD PARTITION, L. AND P. BOTH SIDES



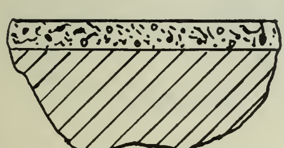
T	T_1	K		
		.33		

DIRT



T	T_1	K		
		.20		

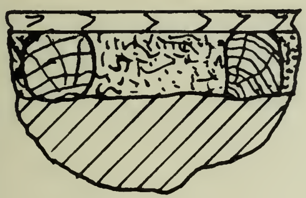
CEMENT OR CONCRETE ON DIRT



T	T_1	K		
		.31		

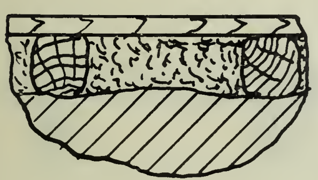
NOTE: FOR ALL FLOORS ABOVE FROST LINE, THE TEMPERATURE OF THE FLOOR MAY BE ASSUMED TO BE HALF THE DIFFERENCE BETWEEN ROOM TEMPERATURE AND OUTSIDE TEMPERATURE.

WOOD FLOOR AND SLEEPER ON DIRT



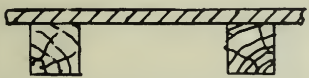
T	T_1	K		
		.13		

WOOD ON SLEEPERS, AND CINDERS ON DIRT



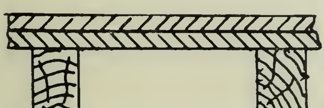
T	T_1	K		
		.12		

SINGLE FLOOR—NO PLASTER



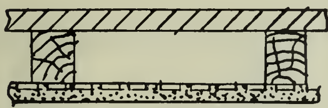
T	T_1	K		
		.29		

DOUBLE FLOOR—NO PLASTER



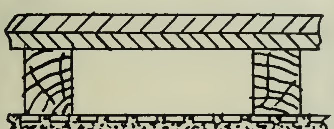
T	T_1	K		
		.20		

SINGLE FLOOR, LATH AND PLASTER BELOW JOIST



T	T_1	K		
		.19		

DOUBLE FLOOR, LATH AND PLASTER BELOW JOIST



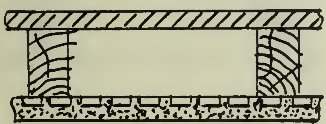
T	T_1	K		
		.13		

WOOD FLOORING, FILLING, AIR SPACE L. AND. P.

T	T_1	K		
		.05		

LATH AND PLASTER WITH WOOD FLOOR ABOVE

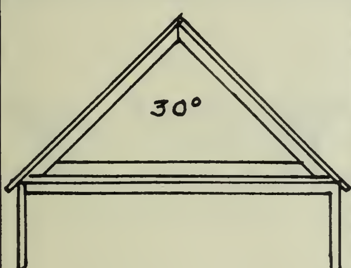
T	T_1	K		
		.28		



LATH AND PLASTER WITH ROOF SPACE ABOVE

T	T_1	K		
		.49		

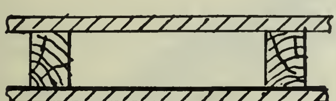
NOTE: TEMPERATURE OF ATTIC SPACE IS ASSUMED TO BE HALF THE DIFFERENCE BETWEEN ROOM TEMPERATURE AND OUTSIDE TEMPERATURE.



WOOD WITH WOOD FLOOR ABOVE

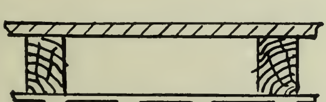
T	T_1	K		
		.40		

WOOD WITH PAPER LINING WITH WOOD FLOOR ABOVE



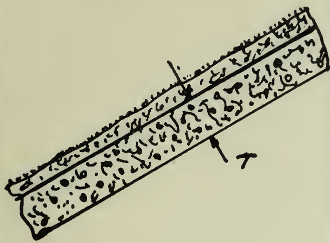
T	T_1	K		
		.25		

STEEL WITH WOOD FLOOR ABOVE



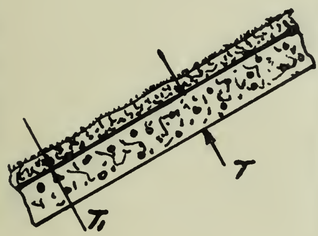
T	T_1	K		
		.35		

TAR AND GRAVEL ON CONCRETE



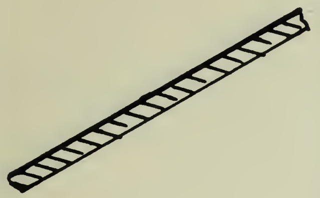
T	T_1	K		
2"		.80		
4"		.60		
6"		.53		

TAR, GRAVEL, AND INSULATOR ON CONCRETE



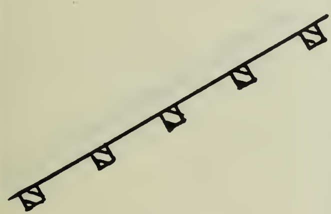
T	T_1	K		
2"	3/4"	.36		
4"	3/4"	.31		
6"	3/4"	.29		

METAL ON TONGUE AND GROOVED SHEATHING



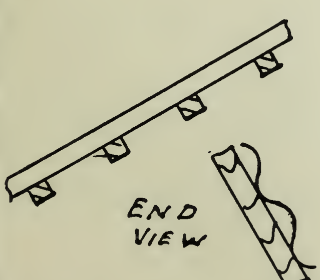
T	T_1	K		
		.42		

METAL ON WOOD FRAME



T	T_1	K		
		1.30		

CORRUGATED IRON ON WOOD FRAME



T	T_1	K		
		1.8		

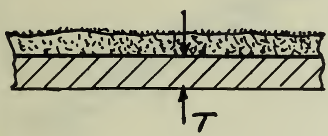
TILE OR SLATE, WITH PAPER ON WOOD SHEATHING

T	T_1	K		
		.38		

TILE OR SLATE ON WOOD SHEATHING

T	T_1	K		
		.80		

TAR AND GRAVEL, TAR PAPER, WOOD PLANKING

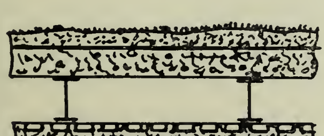


T	T_1	K		
1"		.30		
2"		.26		
3"		.21		

TAR AND GRAVEL, CONCRETE, HOLLOW TILE

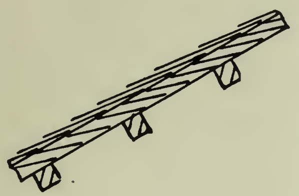
T	T_1	K		
6"		.38		
8"		.36		

TAR AND GRAVEL ON CONCRETE AND SUSPENDED L. AND P.



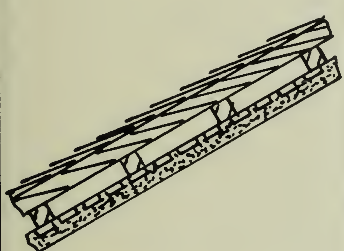
T	T_1	K		
		.30		

SHINGLES SHEATHING AND STUDDING



T	T_1	K		
		.40		

SHINGLES, SHEATHING, STUDDING, LATH AND PLASTER



T.	T_1	K		
		.30		

FOR ROOM TEMPERATURE OF 70° FAHR.
AND STEAM PRESSURE OF 1 LB. GAUGE
DIRECT STEAM RADIATION
(Standard 3 Col. 38″ High) = 225 B.T.U. per sq. ft.
MULTIPLY BY THE FOLLOWING FACTORS FOR THE EQUIVALENT OF 3 Col. 38″ RADIATION OF THE FOLLOWING TYPES.

WALL COIL	.75
DOUBLE WALL COIL	.90
CEILING COIL	1.00
WALL RADIATOR	.82
DOUBLE WALL RADIATORS	1.00
WALL RADIATOR (Ceiling)	1.00

	INCREASE SURFACE
INDIRECT STEAM RADIATION	50%
DIRECT INDIRECT STEAM RADIATION	25%

VAPOR RADIATION: Open return line vapor systems, on which thermostatic traps are not used, require 10% to 20% additional surface in each radiator to act as a condenser and prevent the flow of steam into the return main.

HOT WATER RADIATION: In figuring hot water radiators, assume mean temperature of the water in the radiators to be 170°. Under this condition the amount of hot water radiating surface may be determined by adding 50% to the amount of steam radiating surface figured.

(7-24) First Revision of Page 31—Destroy Original

ROOM TEMPERATURE	70° FAHR
STEAM PRESSURE	1 POUND GAUGE
STEAM RADIATION	
DIRECT RADIATOR (STANDARD: 3 COL. 38" HIGH)	225 B.T.U. PER #
WALL COIL	300 B.T.U. PER #
DOUBLE WALL COIL	250 B.T.U. PER #
CEILING COIL	225 B.T.U. PER #
WALL RADIATOR	275 B.T.U. PER #
DOUBLE WALL RADIATORS	225 B.T.U. PER #
WALL RADIATOR (CEILING)	225 B.T.U. PER #
	INCREASE SURFACE
INDIRECT STEAM RADIATION	50%
DIRECT INDIRECT STEAM RADIATION	25%

VAPOR RADIATION: OPEN RETURN LINE VAPOR SYSTEMS, ON WHICH THERMOSTATIC TRAPS ARE NOT USED, REQUIRE 10% TO 20% ADDITIONAL SURFACE IN EACH RADIATOR TO ACT AS A CONDENSER, AND PREVENT THE FLOW OF STEAM INTO THE RETURN MAIN.

HOT WATER RADIATION: IN FIGURING HOT WATER RADIATORS ASSUME MEAN TEMPERATURE OF THE WATER IN THE RADIATORS TO BE 170° THE AMOUNT OF HOT WATER RADIATING SURFACE MAY BE DETERMINED BY ADDING 50% TO THE AMOUNT OF STEAM RADIATING SURFACE FIGURED

(4-26) First Revision of Page 32—Destroy Original

BASE TEMP.	ROOM TEMPERATURE								
	80	75	70	65	60	55	50	45	40
—5	1.219	1.104	1	.903	.811	.725	.646	.572	.498
0	1.228	1.111	1	.896	.801	.712	.628	.549	.472
+5	1.239	1.119	1	.892	.791	.698	.608	.525	.447
+10	1.253	1.123	1	.886	.780	.680	.586	.498	.415
+15	1.269	1.13	1	.878	.765	.659	.569	.465	.375
+20	1.289	1.14	1	.870	.748	.634	.528	.427	.332
+25	1.312	1.151	1	.859	.728	.604	.489	.380	.277
+30	1.343	1.166	1	.845	.702	.566	.44	.312	.207
+35	1.380	1.183	1	.829	.669	.519			
+40	1.433	1.21	1	.806	.627	.453			
+45	1.504	1.243	1	.773	.561	.363			

FORMULA

$$\text{Factor} = \frac{Tr - Tb}{70 - Tb} \times \frac{Ts - 70}{Ts - Tr}$$

Tr = Room Temp.
Tb = Base Temp.
Ts = 215°

To calculate amount of radiation required for other room temperatures than 70° compute the amount for 70° and multiply by the factor shown corresponding to room temperature desired and proper base temperature.

ROOM TEMP.	OUTSIDE TEMPERATURE								
	−20°	−15°	−10°	−5°	0°	+5°	+10°	+15°	+20°
40°	.72	.66	.60	.54	.47	.42	.36	.30	.24
45°	.79	.73	.67	.61	.55	.49	.43	.37	.30
50°	.88	.82	.75	.69	.63	.56	.50	.44	.38
55°	.97	.91	.84	.78	.71	.65	.58	.52	.45
60°	1.07	1.01	.93	.87	.80	.73	.67	.60	.53
65°	1.17	1.10	1.04	.97	.90	.83	.76	.69	.62
70°	1.29	1.21	1.14	1.07	1.00	.93	.86	.79	.71
75°	1.41	1.34	1.26	1.19	1.11	1.04	.97	.89	.82
80°	1.53	1.46	1.38	1.30	1.23	1.15	1.07	1.00	.92

Obsolete

Type of Opening	Cubic Feet per Hour per Lin. Ft. Crack	Specific Heat Air	Factor
Double Hung Wood Sash	50	.018	0.9
Same with Metal Weather Strip	25	.018	0.45
Stationary Wood Sash	25	.018	0.45
Double Hung Steel Sash	100	.018	1.8
Same with Metal Weather Strip	50	.018	0.9
Rolled Section Steel Window	100*	.018	1.8
Residential Casement Windows, Wood	100	.018	1.8
Same with Metal Weather Strip	50	.018	0.9
Residential Casements, Steel	50	.018	0.9
French Doors	100	.018	1.8
Same with Metal Weather Strip	50	.018	0.9
Outside Doors, Residences	100	.018	1.8
Same with Metal Weather Strip	50	.018	0.9
Same with Storm Doors	50	.018	0.9
Same with Inner Vestibule Doors	50	.018	0.9
Outside Doors, Stores, etc.	200	.018	3.6

* Per foot of crack of ventilating sash.

(4-29) Second Revision Part 1, Page 33—Destroy First Revision

TYPE OF OPENING	CUBIC FEET PER HOUR PER LIN. FT. CRACK	SPECIFIC HEAT AIR	FACTOR
DOUBLE HUNG WOOD SASH	50	.018	0.9
SAME WITH METAL WEA. STRIP	25	.018	0.45
STATIONARY WOOD SASH	25	.018	0.45
DOUBLE HUNG STEEL SASH	100	.018	1.8
SAME WITH METAL WEA. STRIP	50	.018	0.9
FENESTRA TYPE SASH	100	.018	1.8
CASEMENT WINDOWS	100	.018	1.8
SAME WITH METAL WEA. STRIP	50	.018	0.9
FRENCH DOORS	100	.018	1.8
SAME WITH METAL WEA. STRIP	50	.018	0.9
OUTSIDE DOORS	200	.018	3.6
SAME WITH METAL WEA. STRIP	100	.018	1.8
SAME WITH STORM DOOR	100	.018	1.8
SAME WITH INNER VEST DOOR	100	.018	1.8

Obsolete

(4-29) Second Revision Part 1, Page 34—Destroy First Revision

Storm windows, not a permanent part of the building, reduce infiltration approximately 50%.

Fireplaces without dampers increase infiltration.

The factor in the last column on page 33 is the number of B.t.u.s. per lineal foot of crack per hour per degree difference in temperature. This should be multiplied by the total lineal feet of crack to obtain the I used in the formula on page VII.

With three or more exposures and exceptionally good construction an arbitrary reduction not to exceed 25% of the total can be made in the infiltration loss.

(10-25) First Revision Part 1, Page 34—Destroy Original

To determine the lineal feet of crack for fenestra sash add the perimeter of the transom or ventilator to the perimeter of the masonry opening.

Storm windows, not a permanent part of the building, reduce infiltration approximately 50%.

Fireplaces without dampers increase infiltration.

The factor in the last column on page 33 is the number of B.t.u.s. per lineal foot of crack per hour per degree difference in temperature. This should be multiplied by the total lineal feet of crack to obtain the I used in the formula on page VII.

With three or more exposures and exceptionally good construction an arbitrary reduction not to exceed 25% of the total lineal feet of crack can be made in the infiltration loss.

To determine the lineal feet of crack for fenestra sash add the perimeter of the transom or ventilator to the perimeter of the masonry opening.

Storm windows, not a permanent part of the building, reduce infiltration approximately 50%.

Fireplaces without dampers increase infiltration.

The factor in the last column on page 33 is the number of B.t.u.s per lineal foot of crack per hour per degree difference in temperature. This should be multiplied by the total lineal feet of crack to obtain the I used in the formula on page VII.

Obsolete

CITY	Base Temp.	POINTS OF COMPASS							
		N	NE	E	SE	S	SW	W	NW
Albany..........	+ 5°	1.10	1.10	1.05	1.0	1.0	1.0	1.10	1.10
Baltimore........	+30°	1.40	1.40	1.30	1.0	1.30	1.30	1.40	1.40
Birmingham......	+30°	1.15	1.15	1.0	1.0	1.0	1.05	1.15	1.15
Boston..........	+15°	1.30	1.10	1.0	1.0	1.0	1.30	1.30	1.30
Buffalo..........	0°	1.0	1.0	1.0	1.0	1.25	1.40	1.40	1.40
Chicago.........	+10°	1.25	1.0	1.0	1.0	1.15	1.35	1.35	1.35
Cincinnati.......	+15°	1.10	1.0	1.0	1.0	1.35	1.35	1.35	1.20
Cleveland........	+ 5°	1.15	1.08	1.08	1.0	1.08	1.15	1.15	1.15
Denver*.........	+20°	1.30	1.30	1.20	1.25	1.25	1.25	1.0	1.30
Detroit..........	0°	1.10	1.0	1.0	1.0	1.10	1.10	1.10	1.10
Eastport, Me.....	+10°	1.45	1.20	1.20	1.0	1.0	1.45	1.45	1.45
Kansas City, Mo..	+15°	1.45	1.35	1.0	1.0	1.10	1.10	1.45	1.45
Los Angeles......	+50°	1.50	1.50	1.50	1.0	1.0	1.0	1.50	1.50
Madison, Wis....	+ 5°	1.25	1.15	1.10	1.0	1.10	1.25	1.25	1.25
Memphis, Tenn...	+30°	1.40	1.20	1.10	1.0	1.30	1.30	1.40	1.40
Milwaukee.......	+10°	1.25	1.0	1.0	1.0	1.15	1.35	1.35	1.35
New Orleans.....	+45°	1.50	1.40	1.25	1.0	1.0	1.0	1.50	1.50
New York.......	+10°	1.50	1.25	1.0	1.0	1.0	1.33	1.50	1.50
Norfolk..........	+30°	1.50	1.30	1.20	1.0	1.0	1.20	1.50	1.50
Philadelphia......	+15°	1.20	1.10	1.10	1.0	1.0	1.0	1.20	1.20
Pittsburgh.......	+15°	1.30	1.0	1.0	1.0	1.30	1.35	1.35	1.35
Portland, Ore.....	+25°	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Providence, R. I..	+15°	1.50	1.25	1.0	1.0	1.10	1.25	1.50	1.50
Richmond, Va....	+30°	1.35	1.25	1.25	1.0	1.30	1.30	1.35	1.35
Salt Lake City....	+25°	1.10	1.0	1.10	1.10	1.10	1.0	1.10	1.10
San Antonio, Tex.	+45°	1.70	1.70	1.40	1.0	1.0	1.0	1.70	1.70
San Francisco....	+45°	1.20	1.20	1.20	1.0	1.0	1.0	1.0	1.15
St. Louis........	+20°	1.30	1.20	1.0	1.20	1.20	1.20	1.30	1.30
St. Paul.........	— 5°	1.20	1.0	1.0	1.0	1.0	1.10	1.20	1.20
Syracuse.........	0°	1.10	1.0	1.0	1.0	1.05	1.10	1.10	1.10
Washington......	+20°	1.20	1.0	1.0	1.0	1.0	1.0	1.20	1.20

* See Page 36.

(10-27) Third Revision Page 35—Destroy Second Revision

(10-25) Second Revision Page 35—Destroy First Revision

CITY	Base Temp.	POINTS OF COMPASS							
		N	NE	E	SE	S	SW	W	NW
Birmingham.......	+30°	1.15	1.15	1.0	1.0	1.0	1.05	1.15	1.15
Boston..........	+15°	1.30	1.10	1.0	1.0	1.0	1.30	1.30	1.30
Buffalo..........	0°	1.0	1.0	1.0	1.0	1.25	1.40	1.40	1.40
Chicago..........	+ 5°	1.20	1.0	1.0	1.0	1.10	1.25	1.25	1.25
Cincinnati........	+15°	1.10	1.0	1.0	1.0	1.35	1.35	1.35	1.20
Cleveland..........	+ 5°	1.15	1.08	1.08	1.0	1.08	1.15	1.15	1.15
Denver*.........	+20°	1.30	1.30	1.20	1.25	1.25	1.25	1.0	1.30
Detroit..........	0°	1.10	1.0	1.0	1.0	1.10	1.10	1.10	1.10
Eastport, Me. ...	+10°	1.45	1.20	1.20	1.0	1.0	1.45	1.45	1.45
Kansas City, Mo.	+15°	1.45	1.35	1.0	1.0	1.10	1.10	1.45	1.45
Los Angeles......	+50°	1.50	1.50	1.50	1.0	1.0	1.0	1.50	1.50
Madison, Wis.....	+ 5°	1.25	1.15	1.10	1.0	1.10	1.25	1.25	1.25
Memphis, Tenn...	+30°	1.40	1.20	1.10	1.0	1.30	1.30	1.40	1.40
Milwaukee........	+ 5°	1.20	1.0	1.0	1.0	1.10	1.25	1.25	1.25
New York........	+10°	1.50	1.25	1.0	1.0	1.0	1.33	1.50	1.50
Philadelphia.......	+15°	1.20	1.10	1.10	1.0	1.0	1.0	1.20	1.20
Pittsburgh........	+15°	1.30	1.0	1.0	1.0	1.30	1.35	1.35	1.35
Portland, Ore......	+25°	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Salt Lake City......	+25°	1.10	1.0	1.10	1.10	1.10	1.0	1.10	1.10
San Antonio, Tex.	+45°	1.70	1.70	1.40	1.0	1.0	1.0	1.70	1.70
San Francisco....	+45°	1.20	1.20	1.20	1.0	1.0	1.0	1.0	1.15
St. Louis..........	+20°	1.30	1.20	1.0	1.20	1.20	1.20	1.30	1 30
St. Paul..........	— 5°	1.20	1.0	1.0	1.0	1.0	1.10	1.20	1.20
Washington......	+20°	1.20	1.0	1.0	1.0	1.0	1.0	1.20	1.20

Obsolete

* See Page 36.

CITY	Base Temp.	POINTS OF COMPASS							
		N	NE	E	SE	S	SW	W	NW
Birmingham	+30°	1.15	1.15	1.0	1.0	1.0	1.05	1.15	1.15
Boston	+15°	1.30	1.10	1.0	1.0	1.0	1.30	1.30	1.30
Buffalo	0°	1.0	1.0	1.0	1.0	1.25	1.40	1.40	1.40
Chicago	+ 5°	1.20	1.0	1.0	1.0	1.10	1.25	1.25	1.25
Cleveland	+ 5°	1.15	1.08	1.08	1.0	1.08	1.15	1.15	1.15
Denver*	+20°	1.30	1.30	1.20	1.25	1.25	1.25	1.0	1.30
Detroit	0°	1.10	1.0	1.0	1.0	1.10	1.10	1.10	1.10
Kans.C.,Mo.	+15°	1.45	1.35	1.0	1.0	1.10	1.10	1.45	1.45
Los Angeles	+50°	1.50	1.50	1.50	1.0	1.0	1.0	1.50	1.50
Madison Wis	+ 5°	1.25	1.15	1.10	1.0	1.10	1.25	1.25	1.25
Memphis,Tn	+30°	1.40	1.20	1.10	1.0	1.30	1.30	1.40	1.40
Milwaukee,	+ 5°	1.20	1.0	1.0	1.0	1.10	1.25	1.25	1.25
New York	+10°	1.50	1.25	1.0	1.0	1.0	1.33	1.50	1.50
Philadelphia	+15°	1.20	1.10	1.10	1.0	1.0	1.0	1.20	1.20
Pittsburgh	+15°	1.30	1.0	1.0	1.0	1.30	1.35	1.35	1.35
S. Francisco	+45°	1.20	1.20	1.20	1.0	1.0	1.0	1.0	1.15
Salt Lake C.	+25°	1.10	1.0	1.10	1.10	1.10	1.0	1.10	1.10
St. Louis	+20°	1.30	1.20	1.0	1.20	1.20	1.20	1.30	1.30
St. Paul	— 5°	1.20	1.0	1.0	1.0	1.0	1.10	1.20	1.20
Washington	+20°	1.20	1.0	1.0	1.0	1.0	1.0	1.20	1.20

Obsolete

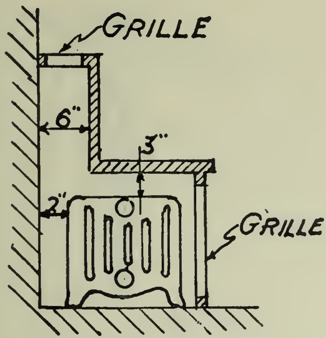
(7-24) First Revision Page 35—Destroy Original

*See Page 36

City	Base Temp.	Points of Compass							
		N	NE	E	SE	S	SW	W	NW
Birmingham	+30°	1.15	1.15	1.0	1.0	1.0	1.05	1.15	1.15
Boston	+15°	1.30	1.10	1.0	1.0	1.0	1.30	1.30	1.30
Buffalo	0°	1.0	1.0	1.0	1.0	1.25	1.40	1.40	1.40
Chicago	+10°	1.25	1.0	1.0	1.0	1.15	1.33	1.33	1.33
Cleveland	+5°	1.15	1.08	1.08	1.0	1.08	1.15	1.15	1.15
Detroit	0°	1.10	1.0	1.0	1.0	1.10	1.10	1.10	1.10
New York	+10°	1.50	1.25	1.0	1.0	1.0	1.33	1.50	1.50
Philadelphia	+15°	1.20	1.10	1.10	1.0	1.0	1.0	1.20	1.20
Pittsburgh	+15°	1.30	1.0	1.0	1.0	1.30	1.35	1.35	1.35
San Francisco	+45°	1.20	1.20	1.20	1.0	1.0	1.0	1.0	1.15
St Louis	+20°	1.30	1.20	1.0	1.20	1.20	1.20	1.30	1.30
St Paul	−5°	1.20	1.0	1.0	1.0	1.0	1.10	1.20	1.20
Washington	+20°	1.20	1.0	1.0	1.0	1.0	1.0	1.20	1.20

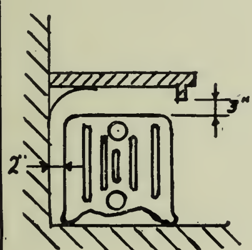
(7-24) First Revision Page 36—Destroy Original

DENVER—Base temperature and exposure factors based on actual Weather Bureau records but due to rapid changes and high altitude square feet of radiation in Standard Radiation Estimating Table are figured on 200 B.t.u. emission instead of 225 B.t.u.



ADD 20%

SEE NOTE PAGE 38



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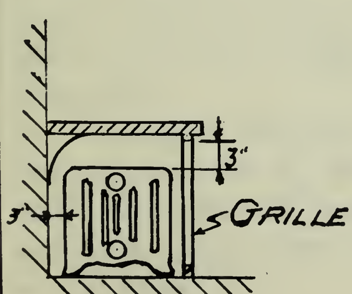
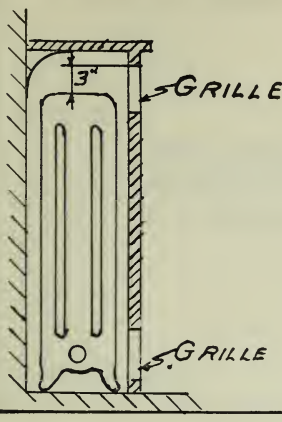
SEE NOTE PAGE 38



ADD 40%

SEE NOTE PAGE 38

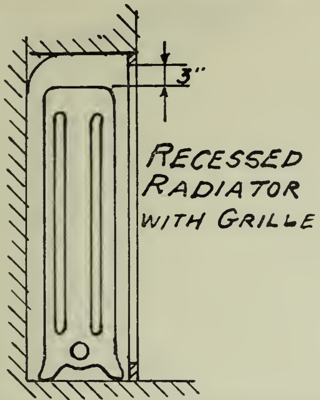


ADD 20%

SEE NOTE PAGE 38

NOTE: WHERE A FLAT SHELF IS PLACED OVER COLUMN RADIATION A CURVED DEFLECTOR SHOULD BE INSTALLED AS SHOWN.

WHERE GRILLES ARE SHOWN THEY ARE TO BE FULL LENGTH OF RADIATOR AND DESIGNED WITH NOT LESS THAN 1½□ NET AREA PER ф OF HEATING SURFACE FOR INLET, AND 2□ NET AREA PER ф OF HEATING SURFACE FOR OUTLET.



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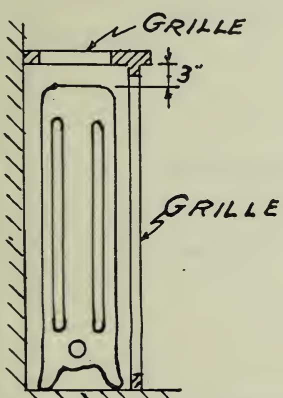
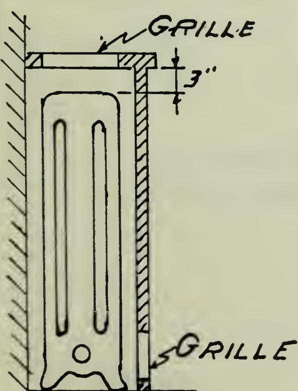
SEE NOTE PAGE 38



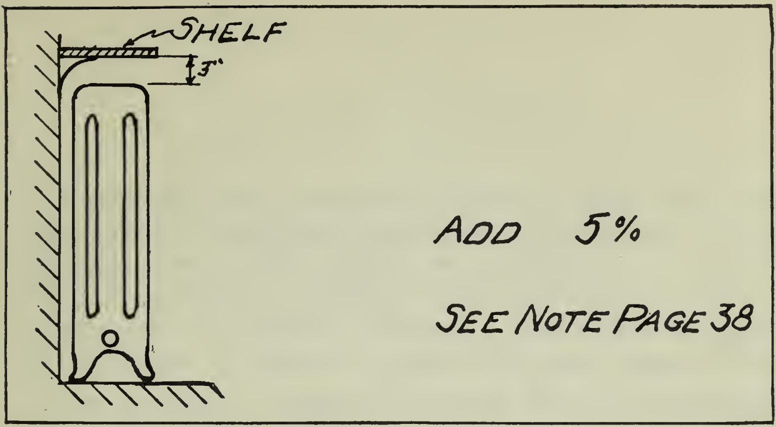
ADD 10%

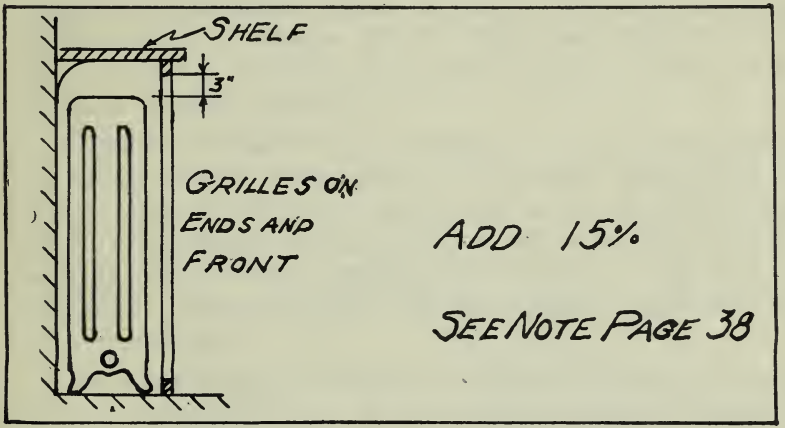
SEE NOTE PAGE 38



ADD 10%

SEE NOTE PAGE 38


SHELF
3"
ADD 5%
SEE NOTE PAGE 38


SHELF
3"
GRILLES ON ENDS AND FRONT
ADD 15%
SEE NOTE PAGE 38

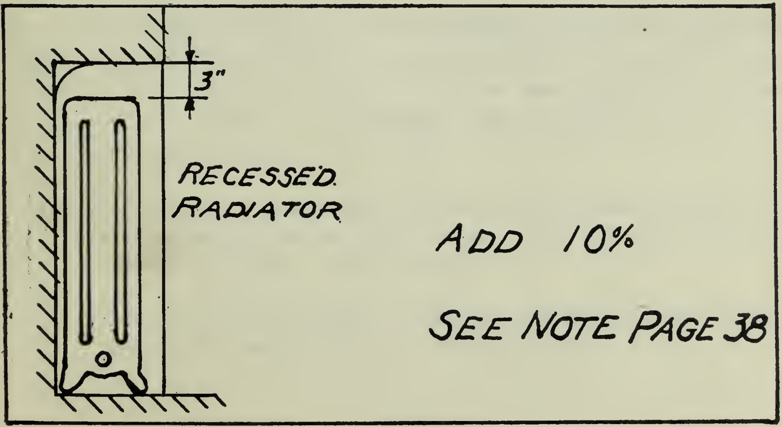

3"
RECESSED RADIATOR
ADD 10%
SEE NOTE PAGE 38

Figure from the plans the number of square feet of wall and glass and lineal feet of crack for each exposure. Find the nearest corresponding quantity in appropriate column. Then read horizontally to extreme left or right hand column for square feet of radiation required. Add additional amount for exposure as shown in upper right hand square of sheet.

For example, for New York City: 70 sq. ft. 12 inch plain brick wall. Then reading down the column (Plain Brick 12″) nearest corresponding figure in table is 70.2 and then going horizontally to extreme left or right gives 6 sq. ft. of 38″ 3 col. radiation. If wall faces north multiply by 1.50 making 9 sq, ft. actually required.

If same wall has 30 sq. ft. of glass or door, nearest corresponding amount under glass is 30.7 which equals 9 sq. ft. times exposure as above equals 13.5 sq. ft. If window has 39 ft. of crack and is double hung wood sash without weather strip the amount falls between 37.6 and 41.7 or 9½ sq. ft. of radiation. Multiplying by 1.50 for exposure equals 14¼ sq. feet of radiation.

The 3 quantities of radiation 9, 13.5 and 14.25 equal 36.75 or for simplicity 37 sq. ft. is the total amount of radiation required for this exposure.

The 3 quantities for any one exposure can be added together and then multiplied by the exposure factor to obtain the same result. No exposure factor is to be used for roofs, floors, ceilings or partitions or skylights unless skylights are vertical or practically vertical.

Note: The exposure factor used in this example is for New York City. See the estimating table for your city, or for city for which estimate is desired, for exposure factor required.

This sheet is to accompany Heating and Piping Contractors National Association Standard Radiation Estimating Table.

TYPE OF WALL	CORK		
	THICKNESS		
	1″	1½″	2″
Brick Wall (with Insulation and Plaster)			
8″ Brick....................	.18	.14	.11
12″ Brick....................	.15	.12	.10
16″ Brick....................	.14	.11	.10
Brick and Hollow Tile (with Insulation and Plaster)			
4″ Brick, 4″ Tile............	.15	.12	.10
4″ Brick, 8″ Tile............	.14	.11	.09
4″ Brick, 12″ Tile............	.12	.09	.08
Standard Frame (with Insulation as plaster base)...................	.13	.11	.09

Issued March, 1928.

TYPE OF WALL	FIBRE BOARD THICKNESS			
	½″	1″		
Brick Wall (Furred, Insulated and Plastered)				
8″ Brick.............	.19	.15		
12″ Brick.............	.17	.14		
16″ Brick.............	.16	.13		
Brick and Hollow Tile (Furred, Insulated and Plastered)				
4″ Brick, 4″ Tile....	.15	.12		
4″ Brick, 8″ Tile....	.14	.11		
4″ Brick, 12″ Tile....	.11	.10		
Standard Frame (Insulated and Plastered — Fibre Board used as plaster base)	.18	.14		
Standard Frame (Fibre Board replacing paper and sheathing).............	.27	.19		

Issued March, 1928.

TYPE OF ROOF OR CEILING	CORK BOARD			FIBRE BOARD	
	THICKNESS			THICKNESS	
	1″	1½″	2″	½″	1″
Plaster Ceiling with wood floor above with insulation as plaster base........	.15	.12	.10	.20	.15
Plaster Ceiling with roof space above with insulation as plaster base...............	.19	.14	.12	.28	.19
Tile or Slate Roof with paper on wood sheathing...........	.17	.13	.11	.24	.17
Tile or Slate Roof on wood sheathing..	.22	.16	.13	.36	.22
Shingle Roof on Sheathing and Studding...	.17	.13	.11	.24	.17

Issued May, 1928.

INFILTRATION

Stationary Wood Sash	25	Rolled Section Steel Windows	100*
Double Hung Wood Sash	50	French Doors	100
Double Hung Steel Sash	100	Outside Doors, Residences	100
Casement Windows, Wood	100	Same with Storm Doors	50
" " Steel	50	Same with Inner Vestibule Doors	50
		Outside Doors, Store, etc.	200

Metal Weather Strip Deducts 50%

*Per foot of crack of Ventilating Sash.

HEATING AND PIPING CONTRACTORS NATIONAL ASSOCIATION

STANDARD RADIATION ESTIMATING TABLE

SHOWING RADIATION REQUIRED FOR QUANTITIES INDICATED

For Other Construction than that Shown See Heating and Piping Contractors National Association Engineering Standards.

CHICAGO
(Also MILWAUKEE, WIS.)

TEMPERATURE FACTORS

Room Temperature 70° = T_i
Base Temperature +10° = T_o
Base Temp. +10° Equivalent to
Guarantee Temp. of —5° Outside

EXPOSURE FACTORS

N	1.25	S	1.15
NE	1.00	SW	1.35
E	1.00	W	1.35
SE	1.00	NW	1.35

3 Col 38" St'm Rad	GLASS		INFILTRATION				OUTSIDE WALLS								
	Win. or Door	Sky Light	Rate per Lin. Ft.				Plain Brick			Brick and Pl.			Brick Fur. L. P.		
			25	50	100	200	8"	12"	16"	8"	12"	16"	8"	12"	16"
	1.1	1.3	0.45	0.9	1.8	3.6	.42	.32	.26	.38	.29	.25	.27	.23	.21
225	66.0	78.0	27.0	54.0	108	216	25.2	19.2	15.6	22.8	17.4	15.0	16.2	13.8	12.6
1	3.41	2.89	8.34	4.17	2.08	1.04	8.93	11.7	14.4	9.9	12.9	15.0	13.9	16.2	17.9
2	6.82	5.78	16.7	8.34	4.16	2.08	17.9	23.4	28.8	19.8	25.8	30.0	27.8	32.4	35.8
3	10.2	8.67	25.0	12.5	6.24	3.12	26.8	35.1	43.2	29.7	38.7	45.0	41.7	48.6	53.7
4	13.6	11.6	33.4	16.7	8.32	4.16	35.7	46.8	58.6	39.6	51.6	60.0	55.6	64.8	71.6
5	17.1	14.5	41.7	20.8	10.4	5.20	44.7	58.5	72.0	49.5	64.5	75.0	69.5	81.0	89.5
6	20.5	17.3	50.0	25.0	12.5	6.24	53.6	70.2	86.4	59.4	77.4	90.0	83.4	97.2	107
7	23.9	20.2	58.4	29.2	14.6	7.28	62.5	81.9	101	69.3	90.3	105	97.3	113	125
8	27.3	23.1	66.7	33.4	16.6	8.32	71.4	93.6	115	79.2	103	120	111	130	143
9	30.7	26.0	75.1	37.6	18.7	9.36	80.4	105	130	89.1	116	135	125	146	161
10	34.1	29.0	83.4	41.7	20.8	10.4	89.3	117	144	99.0	129	150	139	162	179
11	37.6	31.8	91.8	45.9	22.9	11.4	98.2	129	158	109	142	165	153	178	197
12	40.9	34.7	100	50.0	25.0	12.5	107	140	173	119	155	180	167	194	215
13	44.3	37.6	108	54.2	27.0	13.5	116	152	187	129	168	195	181	211	233
14	47.7	40.5	117	58.4	29.1	14.6	125	164	202	139	181	210	195	227	251
15	51.2	43.4	125	62.6	31.2	15.6	134	176	216	149	194	225	209	243	269
16	54.6	46.2	133	66.7	33.3	16.6	143	187	230	158	206	240	222	259	286
17	58.0	49.1	142	70.9	35.4	17.7	152	199	245	168	219	255	236	275	304
18	61.4	52.0	150	75.1	37.4	18.7	161	211	259	178	232	270	250	292	322
19	64.8	54.9	158	79.2	39.5	19.7	170	222	274	188	245	285	264	308	340
20	68.2	57.8	167	83.4	41.6	20.8	179	234	288	198	258	300	278	324	358
21	71.6	60.7	175	87.6	43.7	21.8	187	246	302	208	271	315	292	340	376
22	75.0	63.6	183	91.7	45.8	22.9	196	257	317	218	284	330	306	356	394
23	78.4	66.5	192	96.0	47.8	23.9	205	269	331	228	297	345	320	373	412
24	81.8	69.4	200	100	49.9	25.0	214	281	346	238	310	360	334	389	430
25	85.3	72.3	209	104	52.0	26.0	223	293	360	248	323	375	348	405	448

3 Col 38" St'm Rad	OUTSIDE WALLS											
	Br. 4" Tile Pl.			Plain Conc.			Conc. Fur L. P.			Frame Std.	Frame No Sh'g	Frame No L. P.
	4"	8"	12"	8"	12"	16"	8"	12"	16"			
	.30	.26	.22	.60	.48	.41	.50	.40	.34	.24	.31	.35
225	18.0	15.6	13.2	36.0	28.8	24.6	30.0	24.0	20.4	14.4	18.6	21.0
1	12.5	14.4	17.0	6.25	7.82	9.15	7.5	9.38	11.0	15.6	12.1	10.7
2	25.0	28.8	34.0	12.5	15.6	18.3	15.0	18.8	22.0	31.2	24.2	21.4
3	37.5	43.2	51.0	18.8	23.5	27.5	22.5	28.1	33.0	46.8	36.3	32.1
4	50.0	57.6	68.0	25.0	31.3	36.6	30.0	37.5	44.0	62.4	48.4	42.8
5	62.5	72.0	85.0	31.3	39.1	45.8	37.5	46.9	55.0	78.0	60.5	53.5
6	75.0	86.4	102	37.5	47.0	54.9	45.0	56.3	66.0	93.6	72.6	64.2
7	87.5	101	119	43.8	54.7	64.1	52.5	65.7	77.0	109	84.7	74.9
8	100	115	136	50.0	62.6	73.2	60.0	75.0	88.0	125	96.8	85.6
9	113	130	153	56.3	70.4	82.4	67.5	84.4	99.0	140	109	96.3
10	125	144	170	62.6	78.2	91.5	75.0	93.8	110	156	121	107
11	138	158	187	68.8	86.0	101	82.5	103	121	172	133	118
12	150	173	204	75.0	93.8	110	90.0	113	132	187	145	128
13	163	187	221	81.3	102	119	97.5	122	143	203	157	139
14	175	202	238	87.5	109	128	105	131	154	218	169	150
15	188	216	255	93.8	117	137	113	141	165	234	182	161
16	200	230	272	100	125	146	120	150	176	250	194	171
17	213	245	289	106	133	156	128	159	187	265	206	182
18	225	259	306	113	141	165	135	169	198	281	218	193
19	238	274	323	119	149	174	143	178	209	296	230	203
20	250	288	340	125	156	183	150	188	220	312	242	214
21	263	302	357	131	164	192	158	197	231	328	254	225
22	275	317	374	138	172	201	165	206	242	343	266	235
23	288	331	391	144	180	210	173	216	253	359	278	246
24	300	346	408	150	188	220	180	225	264	374	290	257
25	313	360	425	156	196	229	188	235	275	390	303	268

3 Col 38" St'm Rad	ROOF				Base Floor		Interm'e Floor			Ceiling		Partition			Type
	T & G on 1" Bd.	T & G on 4" Conc.	Sh'gle on Sh'g	Sh'gle Sh'g L. P.	Conc. on Earth	Wood on Sleep.	4" Conc.	4" Conc. 3" Fill 1" Fin.	Double Wood	Lath and Plas.	L & P Wo. Fl. Over	Stud L & P 1 Side	Stud L & P 2 Side		Kind
															Thick.
	.30	.60	.40	.30	.31	.13	.20	.15	.20	.49	.28	.60	.33		K
225	18.0	36.0	24.0	18.0	9.3	3.9	6.0	4.5	6.0	14.7	8.4	18.0	9.9		$K(T_i-T_o)$
1	12.5	6.25	9.38	12.5	24.2	57.7	37.5	50.0	37.5	15.3	26.8	12.5	22.7		1
2	25.0	12.5	18.8	25.0	48.4	115	75.0	100	75.0	30.6	53.6	25.0	45.4		2
3	37.5	18.8	28.1	37.5	72.6	173	113	150	113	45.9	80.4	37.5	68.1		3
4	50.0	25.0	37.5	50.0	96.8	231	150	200	150	61.2	107	50.0	90.8		4
5	62.5	31.3	46.9	62.5	121	289	188	250	188	76.5	134	62.5	114		5
6	75.0	37.5	56.3	75.0	145	346	225	300	225	91.8	161	75.0	136		6
7	87.5	43.8	65.7	87.5	169	404	263	350	263	107	188	87.5	159		7
8	100	50.0	75.0	100	194	462	300	400	300	122	214	100	182		8
9	113	56.3	84.4	113	218	519	338	450	338	138	241	113	204		9
10	125	62.6	93.8	125	242	577	375	500	375	153	268	125	227		10
11	138	68.8	103	138	266	635	413	550	413	168	295	138	250		11
12	150	75.0	113	150	290	692	450	600	450	184	322	150	272		12
13	163	81.3	122	163	315	750	488	650	488	199	348	163	295		13
14	175	87.5	131	175	339	808	525	700	525	214	375	175	318		14
15	188	93.8	141	188	363	866	563	750	563	230	402	188	341		15
16	200	100	150	200	387	923	600	800	600	245	429	200	363		16
17	213	106	159	213	411	981	638	850	638	260	456	213	386		17
18	225	113	169	225	436	1039	675	900	675	275	482	225	409		18
19	238	119	178	238	460	1096	713	950	713	291	509	238	431		19
20	250	125	188	250	484	1154	750	1000	750	306	536	250	454		20
21	263	131	197	263	508	1212	788	1050	788	321	563	263	477		21
22	275	138	206	275	532	1269	825	1100	825	337	590	275	499		22
23	288	144	216	288	557	1327	863	1150	863	352	616	288	522		23
24	300	150	225	300	581	1385	900	1200	900	367	643	300	545		24
25	313	156	235	313	605	1443	938	1250	938	383	670	313	568		25

For Methods of Using Table See Accompanying Sheet.

← These Items Figured on Basis of K $\left(\frac{T_i-T_o}{2}\right)$ →

Obsolete!
Based on +5° instead
of +10° as it should
have been. A.E.W.
See a new sheet

INFILTRATION			
Stationary Wood Sash	25	French Doors	100
Double Hung Wood Sash	50	Outside Doors	200
Double Hung Steel Sash	100	Outside Doors with Storm Doors	100
Casement Windows	100	Outside Doors with Inner Vestibule Doors	100
Fenestra	100		

Metal Weather Strip Deducts 50%

HEATING AND PIPING CONTRACTORS NATIONAL ASSOCIATION

STANDARD RADIATION ESTIMATING TABLE

SHOWING RADIATION REQUIRED FOR QUANTITIES INDICATED

For Other Construction than that Shown See Heating and Piping Contractors National Association Engineering Standards.

CHICAGO
(Also Milwaukee, Wis.)

TEMPERATURE FACTORS	
Room Temperature	$70° = T_i$
Base Temperature	$+5° = T_o$
Base Temp. +5° Equivalent to	
Guarantee Temp. of −10° Outside	

EXPOSURE FACTORS			
N	1.20	S	1.10
NE	1.00	SW	1.25
E	1.00	W	1.25
SE	1.00	NW	1.25

3 Col 38" St'm Rad	GLASS		INFILTRATION				OUTSIDE WALLS																					ROOF				Base Floor		Interm'e Floor			Ceiling		Partition		Type
	Win. or Door	Sky Light	Rate per Lin. Ft.				Plain Brick			Brick and Pl.			Brick Fur. L. P.			Br. 4" Tile Pl.			Plain Conc.			Conc. Fur L. P.			Frame Std.	Frame No Sh'g	Frame No L. P.	T & G on 1" Bd.	T & G on 4" Conc.	Sh'gle on Sh'g	Sh'gle Sh'g L. P.	Conc. on Earth	Wood on Sleep.	4" Conc.	4" Conc. 3" Fill 1" Fin.	Double Wood	Lath and Plas.	L & P Wo. Fl. Over	Stud L & P 1 Side	Stud L & P 2 Side	Kind
			25	50	100	200	8"	12"	16"	8"	12"	16"	8"	12"	16"	4"	8"	12"	8"	12"	16"	8"	12"	16"																	Thick.
	1 1	1.3	0 45	0 9	1 8	3 6	.42	.32	.26	38	.29	25	27	.23	.21	.30	.26	.22	60	.48	.41	.50	.40	34	.24	.31	.35	.30	.60	.40	30	.31	13	.20	15	20	.49	.28	.60	.33	K
225	71.5	84.5	29.3	58.5	117	23.4	27.3	20.8	16.9	24.7	18.8	16.2	17.5	14.9	13.6	19.5	16.9	14.3	39.0	31.2	26.6	32.5	26.0	22.1	15.6	20.1	22.7	19.5	39.0	26.0	19.5	10.8	4.23	6.5	4.87	6.5	15.9	9.1	19.5	10.7	K(Ti-To)
1	3.12	2.66	7.66	3.84	1.92	.96	8.25	10.8	13.31	9.11	11.9	13.8	12.8	15.05	16.5	11.5	13.3	15.7	5.77	7.21	8.45	6.92	8.65	10.2	14.4	11.1	9.89	11.5	5.77	8.65	11.5	20.8	53.0	34.6	46.2	34.6	14.1	24.6	11.5	21.0	1
2	6.24	5.32	15.3	7.68	3.84	1.92	16.5	21.6	26.6	18.2	23.8	27.7	25.7	30.1	33.0	23.0	26.7	31.4	11.5	14.4	16.9	13.8	17.3	20.4	28.8	22.3	19.7	23.0	11.5	17.3	23.0	41.6	106	69.2	92.4	69.2	28.2	49.4	23.0	42.0	2
3	9.36	7.98	22.9	11.5	5.76	2.88	24.7	32.4	39.9	27.3	35.8	41.5	38.5	45.1	49.5	34.5	40.0	47.1	17.3	21.6	25.3	20.7	25.9	30.6	43.2	33.4	29.6	34.5	17.3	25.9	34.5	62.4	159	103	139	103	42.2	74.0	34.6	63.0	3
4	12.4	10.6	30.6	15.3	7.68	3.84	33.0	43.2	53.2	36.4	47.7	55.4	51.4	60.2	66.0	46.0	53.4	62.8	23.0	28.8	33.8	27.6	34.6	40.8	57.6	44.6	39.5	46.0	23.0	34.6	46.0	83.2	212	138	185	138	56.4	106	46.0	84.0	4
5	15.6	13.3	38.3	19.2	9.6	4.82	41.2	54.0	66.5	45.5	59.7	69.2	64.2	75.2	82.5	57.5	66.7	78.5	28.8	36.0	42.2	34.6	43.2	51.1	72.0	55.8	49.4	57.5	28.8	43.2	57.5	104	264	173	231	173	70.4	123	57.6	105	5
6	18.7	15.9	45.9	23.0	11.5	5.7	49.5	64.8	79.8	54.6	71.6	83.1	77.1	90.3	99.0	69.0	80.1	94.2	34.6	43.2	50.7	41.5	51.9	61.3	86.4	66.9	59.3	69.0	34.6	51.9	69.0	125	318	207	277	207	84.6	148	69.2	125	6
7	21.8	18.6	53.6	26.8	13.4	6.72	57.7	75.6	93.1	63.7	83.5	96.9	89.9	105	115	80.5	93.4	110	40.3	50.4	59.1	48.4	60.5	71.5	100	78.1	69.2	80.5	40.3	60.5	80.5	145	370	242	323	242	98.6	172	80.6	146	7
8	24.9	21.2	61.2	30.7	15.3	7.68	66.0	86.4	106	72.8	95.5	110	102	120	132	92.0	106	126	46.1	57.6	67.6	55.3	69.2	81.7	115	89.2	79.1	92.0	46.1	69.2	92.0	166	424	276	369	276	112	197	92.2	167	8
9	28.0	23.9	68.9	34.5	17.2	8.64	74.2	97.2	119	81.9	107	124	116	135	148	103	120	141	51.9	64.8	76.0	62.2	77.8	91.9	129	100	89.0	103	51.9	77.8	103	187	476	311	416	311	126	222	103	188	9
10	31.2	26.6	76.6	38.4	19.2	9.60	82.5	108	133	91.7	119	138	128	150	165	115	133	157	57.7	72.1	84.5	69.2	86.5	102	144	111	98.9	115	57.7	86.5	115	208	530	346	462	346	141	246	115	208	10
11	34.3	29.2	84.2	42.2	21.1	10.5	90.7	118	146	100	131	152	141	165	181	126	146	173	63.4	79.3	92.9	76.1	95.1	112	158	122	108	126	63.4	95.1	126	229	582	380	508	380	155	270	126	230	11
12	37.4	31.9	91.9	46.0	23.0	11.5	99.0	129	159	109	143	166	154	180	198	138	160	188	69.2	86.5	101	83.0	103	122	172	133	118	138	69.2	103	138	250	636	414	554	414	169	294	138	250	12
13	40.6	34.5	99.5	49.9	24.9	12.4	107	140	173	118	155	180	167	195	214	149	173	204	75.0	93.7	109	89.9	112	132	187	145	128	149	75.0	112	149	270	688	449	600	449	183	320	150	272	13
14	43.6	37.2	107	53.7	26.8	13.4	115	151	186	127	167	193	179	210	231	161	186	220	80.7	100	118	96.8	121	143	201	156	138	161	80.7	121	161	291	742	484	646	484	197	344	161	292	14
15	46.8	39.9	114	57.6	28.8	14.4	123	162	199	136	179	207	192	225	247	172	200	236	86.5	108	126	103	129	153	216	167	148	172	86.5	129	172	312	794	518	683	518	210	370	173	314	15
16	49.9	42.5	122	61.4	30.7	15.3	132	172	212	145	191	221	206	240	264	184	213	251	92.3	115	135	110	138	163	230	178	158	184	92.3	138	184	333	848	553	739	553	224	394	184	334	16
17	53.0	45.2	130	65.2	32.6	16.3	140	183	226	154	202	235	218	255	280	195	226	267	98.0	122	143	117	147	173	244	189	168	195	98.0	147	195	354	900	588	785	588	238	419	196	356	17
18	56.1	47.8	137	69.1	34.5	17.2	148	194	239	163	214	249	231	270	297	207	240	283	103	129	152	124	155	183	259	200	178	207	103	155	207	375	954	622	832	622	252	444	206	375	18
19	59.2	50.5	145	72.9	36.4	18.2	156	205	252	173	226	263	244	285	313	218	253	298	109	136	160	131	164	194	273	212	187	218	109	164	218	395	1006	657	878	657	266	468	218	396	19
20	62.4	53.2	153	76.8	38.5	19.2	165	216	266	182	238	277	257	301	330	230	267	314	115	144	169	138	173	204	288	223	197	230	115	173	230	416	1060	692	924	692	282	494	230	418	20
21	65.5	55.8	160	80.6	40.4	20.1	173	227	279	191	250	290	269	316	346	241	280	330	121	151	177	145	181	214	302	234	207	241	121	181	241	437	1112	726	970	726	296	518	242	440	21
22	68.6	58.5	168	84.4	42.3	21.1	181	237	292	200	262	304	282	331	363	253	293	345	126	158	185	152	190	224	316	245	217	253	126	190	253	458	1166	760	1014	760	310	542	252	460	22
23	71.7	61.1	176	88.3	44.2	22.0	189	248	305	209	274	318	295	346	379	264	307	361	132	165	194	159	198	235	331	256	227	264	132	198	264	478	1218	795	1060	795	324	568	264	482	23
24	74.8	63.8	183	92.1	46.1	23.0	198	259	319	218	286	332	308	361	396	276	320	377	138	173	202	166	207	245	345	267	237	276	136	207	276	499	1272	830	1108	830	338	592	276	502	24
25	78.0	66.5	191	96.0	48.0	24.0	206	270	332	227	298	346	321	376	412	287	333	393	144	180	211	173	216	255	360	279	247	287	144	216	287	520	1324	864	1155	864	352	616	288	524	25

For Methods of Using Table See Accompanying Sheet.

← These Items Figured on Basis of K $\left(\frac{T_i - T_o}{2}\right)$ →

PART II.

NET SQUARE FEET RADIATION LOADS IN 70° FAHRENHEIT, RECOMMENDED FOR LOW PRESSURE HEATING BOILERS.

FOREWORD

ALLOWANCES

THE net loads recommended for direct cast iron column radiation includes allowances for heat loss of piping system, morning peak load and attention factor. When the actual surface, in square feet, of the piping system exceeds 20 per cent of the direct cast iron column radiation additional allowance should be made for the extra surface.

BOILER LOADS

The net loads recommended in chart for boilers is based upon the use of bituminous coal having a heat value of 12,000 B. T. U. for sizes up to 520 square feet net load, and 11,000 B. T. U. for all ratings over 520 square feet net load. When the coal to be used has a heat value less than 11,000 or 12,000 B. T. U. the direct cast iron column radiation shall be multiplied by the factor corresponding to the heat value of the coal used.

Factors to be used in determining boiler size where the heat value of fuel is other than 12,000 B. T. U.

Heat Value of Coal In B. T. U. Per Lb.	Factor For Net Loads Under 520 Sq. Ft.
12,000	1.00
11,500	1.04
11,000	1.09
10,500	1.14
10,000	1.20

Factors to be used in determining boiler size when the heat value of fuel is other than 11,000 B. T. U.

Heat Value of Coal In B. T. U. Per Lb.	Factors For Net Loads Over 520 Sq. Ft.
11,000	1.00
10,500	1.05
10,000	1.10
9,500	1.16
9,000	1.22
8,500	1.30
8,000	1.38

RULES FOR COMPUTING NET BOILER LOADS FOR EQUIVALENT DIRECT CAST IRON COLUMN RADIATION

Direct Cast Iron Radiation

It is assumed that Direct Cast Iron Column Radiation will emit 225 B. T. U. per hour per square foot of surface for steam, and 150 B. T. U. per hour per square foot of surface for water, therefore all radiation must be reduced to this heat emission basis.

Rule for Computing Net Boiler Loads for Other Than Cast Iron Column Radiation

Reduce to equivalent cast iron column radiation by adding 25% to pipe coils or cast iron wall radiators on side walls and direct-indirect radiation, and 50% to indirect radiation without fan.

Rule for Computing Net Boiler Loads for Lower Inside Temperatures Than 70° F.

If building is to be heated to less than 70° multiply the equivalent net C. I. column radiation load by the following factors for proper net boiler load:

	Steam	Water
70°	1.	1.
65°	1.03	1.03
60°	1.07	1.07
55°	1.10	1.10
50°	1.13	1.13
45°	1.17	1.17
40°	1.20	1.20

Rule for Computing Boiler Size for Hot Blast Coils

For computing boiler size to be used for Hot Blast Coils use manufacturer's condensation chart and figure .375 lb. of condensation per hour as equivalent to one square foot of direct column radiation.

Rules for Computing Boiler Size for Unit Heaters

For boiler size to be used on unit heater for recirculating air, base unit heater on amount of equivalent direct radiation required.

Rule for Computing Boiler Size for Heating Water for Domestic Use

When water for domestic use is heated by heating boiler, by means of coil in firebox or steam coil in storage tank, size of

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[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

boiler should be increased, figuring each gallon of water tank capacity as equivalent to two square feet of steam radiation or three square feet of hot water radiation.

For example, a 160-gallon tank should be figured as equivalent to 320 square feet of steam radiation or 480 square feet of hot water radiation.

When water for domestic use is heated by submerged heater with storage tank figure each gallon tank capacity as equivalent to one-half square foot of direct radiation.

For submerged heaters without storage tank, size of boiler to be increased as follows: For each gallon of water to be heated per hour add four square feet of direct radiation.

Rule for Computing Net C. I. Column Radiation Equivalent Load for Boilers Selected from Net Load Chart

EXAMPLE—

(1) 500 sq. ft. of direct cast iron column radiation in room to be heated to 70° F.
(2) 500 sq. ft. of direct cast iron column radiation in room to be heated to 50° F.
(3) 500 sq. ft. of cast iron wall radiation or wall pipe coils in room to be heated to 50° F.
(4) 500 sq. ft. of gravity indirect radiation.
(5) 500 sq. ft. of direct-indirect radiation.
(6) 250-gal. hot water tank. Water to be heated with steam coil.
(7) 500 sq. ft. of cast iron hot blast radiation, having a condensation rate of 1.92 lbs. of steam per hour per sq. ft. with incoming air at —10° F.

SOLUTION—

(1)	500 sq. ft. x 1.0	500 sq. ft.
(2)	500 sq. ft. x 1.13	565 " "
(3)	500 sq. ft. x 1.25x1.13	707 " "
(4)	500 sq. ft. x 1.5	750 " "
(5)	500 sq. ft. x 1.25	625 " "
(6)	250 gal. x 2	500 " "
(7)	(500x1.92) divided by .375	2560 " "
	C. I. column radiation equivalent load	6207 sq. ft.

CHIMNEYS

Due to the wide variation in boiler design, the length and nature of the gas passage, the nature of the fuel burned and the rate of combustion all of which affects directly the draft pressure required, it is recommended that the chimney sizes

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

given by the various manufacturers for their boilers be used for both round and square sectional cast iron boilers. It is advisable that chimney have approximately 25 per cent excess area of smoke collar on the boiler.

A poor draft means imperfect combustion, therefore it is highly important that all boilers be attached to chimneys providing sufficient draft to consume with proper combustion the required amount of fuel per hour.

It is also important that the chimney be so located with reference to adjacent buildings or objects nearby that draft will not be interfered with.

Round flues will give a better draft than a square or other rectangular shape, having the same cross-sectional area. Round flues are recommended where it is practical to obtain them.

To secure the most satisfactory draft conditions, the area and the height of a chimney must be proportioned to the size and character of heating appliance attached to it and all flue chimney connections made perfectly tight.

To Determine Net Loads for Boilers Having a Grate Width Other Than in Tables

EXAMPLE—To find the net load for a boiler 80 inches long having grate $40\frac{1}{4}$ inches wide.

SOLUTION—Table (Page 8) gives net load for boiler 80 inches long and grate 40 inches wide and 41 inches wide. Therefore, the $40\frac{1}{4}$ inch grate width will carry **one fourth** the difference between the net loads given in table for grates 40 and 41 inches in width or in this case:

Net load for boiler with a 41 inch grate and 80 inches long is	3993 sq. ft.
Net load for boiler with a 40 inch grate and 80 inches long	3870 sq. ft.
Difference	123 sq. ft.

in net load for 1 inch of grate width for a boiler 80 inches long. Therefore, $\frac{1}{4}$ inch in grate width would equal **one fourth** of 123 or 30.75 sq. ft. which added to 3870 sq. ft. gives net load of 3900.75 sq. ft. for a boiler 80 inches long having a grate width of $40\frac{1}{4}$ inches.

To Determine Net Load for Boiler Having a Length Other Than Given in Tables

EXAMPLE—To find the net load for a boiler having a length 81 inches and grate width of 40 inches.

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SOLUTION—Table (Page 8) gives net loads for boilers having lengths of 80 and 82 inches with grate width of 40 inches. Therefore, the boiler 81 inches in length will carry one half the difference between the net loads given in the table for the 80 inch length and 82 inch length or in this case:

Net load for boiler 82 inches long and 40 inch grate is ....3997 sq. ft.

Net load for boiler 80 inches long and 40 inch grate is ....3870 sq. ft.

Difference .... 127 sq. ft.

for 2 inches in boiler length. Therefore, 1 inch in length would equal one half of 127 sq. ft. or 63.5 sq. ft., which added to 3870 sq. ft. gives a net load of 3933.5 sq. ft. for a boiler 81 inches long having a grate width of 40 inches.

RECOMMENDATIONS

It is recommended that no boiler be installed having a grate longer than 72 inches.

Also that in all installations of steam boiler that drain valves be placed on the returns and that the condensation from such returns be discharged into the sewer for a period of from three days to one week after starting fire, thereby clearing system of grease and dirt. At the end of this period boiler should be thoroughly washed and blown out.

Issued July, 1928

HEATING AND PIPING CONTRACTORS NATIONAL ASSOCIATION

ROUND BOILERS

Recommendations For Net Sq. Ft. Radiation Loads In 70° Fahrenheit

Actual Diameter of Grate	Number of Intermediate Sections Between Fire Pot and Dome	No Crown Sheet Cast on Fire Pot Section Net Radiation Loads			With Crown Sheet Cast on Fire Pot Section Net Radiation Loads			
		Assemblages	Steam	Water	Assemblages	Steam	Water	Minimum Chimney Requirements
15	0	A	90	135	A½	95	143	8x 8x30
	1	A1	97	145	A1½	102	153	8x 8x30
	2	A2	104	156	A2½	109	164	8x 8x30
	3	A3	111	167	A3½	116	174	8x 8x35
	4	A4	118	177	A4½	123	185	8x 8x35
16	0	A	110	165	A½	118	177	8x 8x30
	1	A1	120	180	A1½	128	192	8x 8x30
	2	A2	130	195	A2½	138	207	8x 8x30
	3	A3	140	210	A3½	148	222	8x 8x35
	4	A4	150	225	A4½	158	237	8x 8x35
17	0	A	135	203	A½	143	215	8x 8x30
	1	A1	145	218	A1½	153	230	8x 8x30
	2	A2	155	233	A2½	163	245	8x 8x30
	3	A3	165	248	A3½	173	260	8x 8x35
	4	A4	175	263	A4½	183	275	8x 8x35
18	0	A	157	236	A½	166	249	8x 8x30
	1	A1	170	255	A1½	179	269	8x 8x30
	2	A2	183	275	A2½	192	288	8x 8x30
	3	A3	195	293	A3½	204	306	8x 8x35
	4	A4	208	312	A4½	217	326	8x 8x35
19	0	A	180	270	A½	191	287	8x 8x30
	1	A1	195	293	A1½	206	309	8x 8x30
	2	A2	210	315	A2½	221	332	8x 8x35
	3	A3	225	338	A3½	236	354	8x 8x35
	4	A4	240	360	A4½	251	377	8x 8x35
20	0	A	205	308	A½	216	324	8x 8x35
	1	A1	220	330	A1½	231	347	8x 8x35
	2	A2	235	353	A2½	246	369	8x 8x35
	3	A3	250	375	A3½	261	392	8x12x35
	4	A4	265	398	A4½	276	414	8x12x40
21	0	A	238	357	A½	251	377	8x12x35
	1	A1	255	383	A1½	268	402	8x12x35
	2	A2	272	408	A2½	285	428	8x12x35
	3	A3	290	435	A3½	303	455	8x12x40
	4	A4	308	462	A4½	321	482	8x12x40
22	0	A	270	405	A½	285	428	8x12x35
	1	A1	290	435	A1½	305	458	8x12x35
	2	A2	310	465	A2½	325	488	10x10x35
	3	A3	330	495	A3½	345	518	10x10x40
	4	A4	350	525	A4½	365	548	10x10x40
23	0	A	295	443	A½	314	471	10x10x35
	1	A1	320	480	A1½	339	509	10x10x35
	2	A2	345	518	A2½	364	546	10x10x35
	3	A3	370	555	A3½	389	584	10x10x40
	4	A4	395	593	A4½	414	621	10x10x40
24	0	A	320	480	A½	342	513	10x10x35
	1	A1	350	525	A1½	372	558	10x10x35
	2	A2	380	570	A2½	402	603	10x10x35
	3	A3	410	615	A3½	432	648	10x10x40
	4	A4	440	660	A4½	462	693	10x10x40
25	0	A	345	518	A½	371	557	10x10x35
	1	A1	380	570	A1½	406	609	10x10x35
	2	A2	415	623	A2½	441	662	10x10x40
	3	A3	450	675	A3½	476	714	10x10x40
	4	A4	485	728	A4½	511	767	10x10x45
26	0	A	375	563	A½	405	608	12x12x35
	1	A1	415	623	A1½	445	668	12x12x35
	2	A2	455	683	A2½	485	728	12x12x35
	3	A3	495	743	A3½	525	788	12x12x40
	4	A4	535	803	A4½	565	848	12x12x40
27	0	A	410	615	A½	444	666	12x12x35
	1	A1	455	683	A1½	489	734	12x12x35
	2	A2	500	750	A2½	534	801	12x12x35
	3	A3	545	818	A3½	579	869	12x12x40
	4	A4	590	885	A4½	624	936	12x12x40
28	0	A	455	683	A½	492	738	12x12x35
	1	A1	505	758	A1½	542	813	12x12x35
	2	A2	555	833	A2½	592	888	12x12x40
	3	A3	605	908	A3½	642	963	12x12x40
	4	A4	655	983	A4½	692	1038	12x12x45
29	0	A	500	750	A½	541	812	12x12x35
	1	A1	555	833	A1½	596	894	12x12x35
	2	A2	610	915	A2½	651	977	12x12x40
	3	A3	665	998	A3½	706	1059	12x12x40
	4	A4	720	1080	A4½	761	1142	12x12x45
30	0	A	550	825	A½	595	893	12x12x35
	1	A1	610	915	A1½	655	983	12x12x35
	2	A2	670	1005	A2½	715	1073	12x12x40
	3	A3	730	1095	A3½	775	1163	12x12x40
	4	A4	790	1185	A4½	835	1253	12x12x45
31	0	A	605	908	A½	654	981	12x12x40
	1	A1	670	1005	A1½	719	1079	12x12x40
	2	A2	735	1103	A2½	785	1178	12x12x40
	3	A3	795	1193	A3½	844	1266	12x12x45
	4	A4	860	1290	A4½	909	1364	12x12x45
32	0	A	665	998	A½	717	1076	12x12x40
	1	A1	735	1103	A1½	787	1181	12x12x40
	2	A2	805	1208	A2½	857	1286	12x12x40
	3	A3	875	1313	A3½	927	1391	12x12x45
	4	A4	945	1418	A4½	997	1496	12x12x45
33	0	A	725	1088	A½	777	1106	12x16x40
	1	A1	795	1193	A1½	847	1271	12x16x40
	2	A2	865	1298	A2½	917	1376	12x16x40
	3	A3	935	1403	A3½	987	1481	12x16x45
	4	A4	1005	1508	A3½	1057	1586	12x16x45
34	0	A	785	1178	A½	837	1256	12x16x40
	1	A1	855	1283	A1½	907	1361	12x16x40
	2	A2	925	1388	A2½	977	1466	12x16x45
	3	A3	995	1493	A3½	1047	1571	12x16x45
	4	A4	1065	1598	A4½	1117	1676	12x16x45

Issued July 1928
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HEATING AND PIPING CONTRACTORS NATIONAL ASSOCIATION

RECOMMENDATIONS

For Straight Draft or Smokeless Type Cast Iron Square Boilers

Grate length for all boilers is based on entire inside length not exceeding 72 inches

NET SQ. FT. RADIATION LOADS IN 70° FAHRENHEIT

Boiler Length is Between Outside Face of Front and Rear Sections	GRATE WIDTH 14″		GRATE WIDTH 15″		GRATE WIDTH 16″		GRATE WIDTH 17″	
	Steam	Water	Steam	Water	Steam	Water	Steam	Water
16	140	210	145	218	150	225	155	232
18	166	249	173	260	180	270	187	280
20	192	288	201	302	210	315	219	328
22	218	327	229	344	240	360	251	376
24	244	366	257	385	270	405	283	424
26	270	405	285	428	300	450	315	472
28	296	444	313	470	330	495	347	520
30	322	483	341	511	360	540	379	569
32	350	525	371	556	392	588	413	620
34	378	566	401	602	424	636	447	670
36	406	609	431	646	456	685	481	722
38	434	650	461	692	488	732	515	773
40	462	694	491	737	520	780	550	825
42	490	735	521	782	553	830	585	878
44	518	778	552	829	586	880	620	930
46	547	820	583	875	619	929	655	983
48	576	865	614	920	652	980	690	1035
50	605	908	645	968	685	1030	725	1090
52	631	946	675	1010	719	1080	763	1145
54	657	985	705	1060	753	1130	801	1200
56	683	1025	735	1100	787	1180	839	1260
58	709	1060	765	1150	821	1230	877	1320
60	735	1100	795	1190	855	1280	915	1370
62	761	1140	825	1240	889	1330	953	1430
64	787	1180	855	1280	923	1380	991	1490
66	813	1120	885	1330	957	1440	1029	1540
68	839	1260	915	1370	991	1490	1067	1600
70	865	1300	945	1420	1025	1540	1105	1660
72	892	1340	976	1460	1060	1590	1144	1720
74	919	1380	1007	1510	1095	1640	1183	1775
76	946	1420	1038	1557	1130	1695	1222	1832
78	973	1460	1069	1603	1165	1745	1261	1890
80	1000	1500	1100	1650	1200	1800	1300	1950

(11-28) First Revision of Page 2—Destroy Original

Boiler Length is Between Outside	GRATE WIDTH 18″	GRATE WIDTH 19″	GRATE WIDTH 20″	GRATE WIDTH 21″

Boiler Length is Between Outside Face of Front and Rear Sections	GRATE WIDTH 18″		GRATE WIDTH 19″		GRATE WIDTH 20″		GRATE WIDTH 21″	
	Steam	Water	Steam	Water	Steam	Water	Steam	Water
16	160	240	165	247	170	255	176	264
18	194	291	201	301	208	312	216	324
20	228	342	237	355	246	369	256	384
22	262	393	273	409	284	426	296	444
24	296	444	309	463	322	483	336	504
26	330	495	345	518	360	540	376	564
28	364	543	381	572	398	597	416	624
30	398	597	417	625	436	654	456	684
32	434	651	455	682	476	714	499	748
34	470	706	493	740	517	776	542	813
36	506	759	532	798	558	837	585	877
38	543	814	571	856	599	899	628	942
40	580	870	610	915	640	960	671	1006
42	617	925	649	974	681	1021	714	1071
44	654	981	688	1032	722	1083	758	1137
46	691	1035	727	1090	763	1144	802	1203
48	728	1091	766	1150	804	1206	846	1269
50	765	1146	805	1260	845	1267	890	1335
52	807	1210	851	1276	895	1342	944	1416
54	849	1273	897	1345	945	1417	998	1497
56	891	1336	943	1414	995	1492	1052	1578
58	933	1400	989	1483	1045	1567	1106	1659
60	975	1461	1035	1551	1095	1643	1160	1740
62	1017	1525	1081	1621	1145	1717	1214	1821
64	1059	1589	1127	1690	1195	1793	1268	1902
66	1101	1650	1173	1760	1245	1868	1322	1983
68	1143	1715	1219	1829	1295	1941	1376	2064
70	1185	1778	1265	1897	1345	2020	1430	2145
72	1228	1841	1312	1967	1396	2092	1485	2227
74	1271	1906	1359	2040	1447	2170	1540	2310
76	1314	1970	1406	2110	1498	2247	1595	2392
78	1357	2035	1453	2180	1549	2323	1650	2475
80	1400	2100	1500	2250	1600	2400	1705	2557
82					1640	2460	1745	2617
84					1677	2516	1780	2670
86					1718	2587	1810	2715
88					1742	2613	1836	2754
90					1755	2632	1860	2790
92					1772	2658	1882	2823
94					1790	2685	1903	2854
96					1802	2703	1925	2887
98					1813	2719	1942	2913
100					1820	2730	1955	2932

(11-28) First Revision of Page 3—Destroy Original

Boiler Length is Between Outside	GRATE WIDTH 22″	GRATE WIDTH 23″	GRATE WIDTH 24″	GRATE WIDTH 25″

Boiler Length is Between Outside Face of Front and Rear Sections	GRATE WIDTH 22″		GRATE WIDTH 23″		GRATE WIDTH 24″		GRATE WIDTH 25″	
	Steam	Water	Steam	Water	Steam	Water	Steam	Water
16	182	273	188	282	194	291	200	300
18	224	336	232	348	240	360	248	374
20	266	399	276	414	286	429	296	444
22	308	462	320	480	332	498	344	516
24	350	525	364	546	378	567	392	588
26	392	588	408	612	424	636	440	660
28	434	651	452	678	470	705	488	732
30	476	714	496	744	516	774	536	804
32	521	781	544	816	566	850	589	884
34	567	850	592	888	617	925	643	964
36	613	919	640	960	668	1002	697	1045
38	659	988	688	1031	719	1078	751	1126
40	705	1057	736	1104	770	1155	805	1207
42	751	1126	784	1176	821	1231	859	1288
44	797	1195	833	1249	872	1308	913	1369
46	843	1264	882	1323	923	1384	976	1450
48	889	1333	931	1396	974	1461	1021	1531
50	935	1402	980	1470	1025	1537	1075	1612
52	993	1489	1042	1563	1091	1636	1145	1717
54	1051	1576	1104	1655	1157	1735	1215	1822
56	1109	1663	1166	1750	1223	1835	1285	1927
58	1167	1750	1228	1840	1289	1933	1355	2030
60	1225	1837	1290	1935	1355	2030	1425	2135
62	1283	1924	1352	2030	1421	2130	1495	2240
64	1341	2011	1414	2120	1487	2230	1565	2350
66	1399	2098	1476	2215	1553	2330	1635	2450
68	1457	2185	1538	2310	1619	2430	1705	2560
70	1515	2272	1600	2400	1685	2530	1775	2660
72	1574	2361	1663	2490	1752	2630	1846	2770
74	1633	2449	1726	2590	1819	2730	1917	2870
76	1692	2538	1789	2680	1886	2830	1988	2980
78	1751	2626	1852	2780	1953	2930	2059	3090
80	1810	2715	1915	2870	2020	3030	2130	3195
82	1850	2775	1955	2930	2070	3105	2185	3275
84	1882	2823	1995	2990	2112	3170	2240	3360
86	1912	2868	2028	3040	2155	3230	2277	3415
88	1942	2913	2060	3090	2188	3280	2313	3470
90	1970	2955	2090	3135	2220	3330	2350	3525
92	1995	2992	2118	3175	2250	3380	2382	3570
94	2020	3030	2142	3215	2280	3420	2412	3620
96	2045	3067	2175	3260	2305	3460	2442	3660
98	2067	3100	2200	3300	2327	3490	2468	3700
100	2090	3135	2225	3337	2350	3525	2495	3740

(11-28) First Revision of Page 4—Destroy Original

Boiler Length is Between Outside Face of Front and Rear Sections	GRATE WIDTH 26″		GRATE WIDTH 27″		GRATE WIDTH 28″		GRATE WIDTH 29″	
	Steam	Water	Steam	Water	Steam	Water	Steam	Water
16	206	309	212	318	218	327	225	337

Boiler Length is Between Outside Face of Front and Rear Sections	GRATE WIDTH 26″		GRATE WIDTH 27″		GRATE WIDTH 28″		GRATE WIDTH 29″	
	Steam	Water	Steam	Water	Steam	Water	Steam	Water
16	206	309	212	318	218	327	225	337
18	256	384	264	396	272	408	281	423
20	306	459	316	474	326	489	337	506
22	356	534	368	552	380	570	393	590
24	406	609	420	630	434	650	449	674
26	456	684	472	708	488	732	505	758
28	506	750	524	786	542	813	561	842
30	556	834	576	864	596	894	617	926
32	612	918	635	952	658	987	683	1024
34	669	1003	695	1042	721	1081	749	1123
36	726	1089	755	1132	784	1176	815	1222
38	783	1174	815	1222	847	1270	881	1321
40	840	1260	875	1312	910	1365	947	1420
42	897	1345	935	1402	973	1459	1013	1520
44	954	1431	995	1492	1036	1555	1079	1620
46	1011	1516	1055	1582	1099	1650	1146	1720
48	1068	1602	1115	1672	1162	1742	1213	1820
50	1125	1687	1175	1762	1225	1837	1280	1920
52	1199	1800	1253	1880	1307	1960	1366	2050
54	1273	1910	1331	1996	1389	2080	1452	2180
56	1347	2020	1409	2115	1471	2210	1538	2308
58	1421	2130	1487	2230	1553	2330	1624	2435
60	1495	2240	1565	2346	1635	2450	1710	2565
62	1569	2350	1643	2465	1717	2580	1796	2693
64	1643	2460	1721	2580	1799	2700	1882	2820
66	1717	2575	1799	2700	1881	2820	1968	2995
68	1791	2688	1877	2815	1963	2942	2054	3080
70	1865	2800	1955	2930	2045	3070	2140	3210
72	1940	2910	2034	3050	2128	3175	2227	3340
74	2015	3020	2113	3170	2211	3320	2314	3470
76	2090	3135	2192	3290	2294	3440	2401	3600
78	2165	3250	2271	3406	2377	3565	2488	3730
80	2240	3360	2350	3525	2460	3690	2575	3860
82	2300	3450	2414	3620	2520	3780	2640	3960
84	2355	3530	2470	3705	2575	3860	2695	4040
86	2400	3600	2520	3780	2620	3930	2742	4115
88	2442	3665	2563	3845	2663	4000	2790	4185
90	2478	3715	2605	3910	2702	4050	2835	4255
92	2510	3765	2640	3960	2745	4120	2870	4305
94	2542	3815	2675	4010	2784	4180	2917	4380
96	2572	3860	2707	4060	2822	4235	2958	4440
98	2603	3905	2738	4105	2860	4290	2997	4495
100	2630	3945	2765	4150	2900	4350	3035	4550
102	2652	3980	2791	4185	2927	4395	3065	4600
104	2670	4005	2812	4220	2952	4425	3092	4640
106	2683	4025	2828	4240	2972	4455	3117	4670
108	2692	4040	2840	4260	2987	4480	3135	4700
110	2700	4050	2850	4275	3000	4500	3150	4725

(11-28) First Revision of Page 5—Destroy Original

Boiler Length is Between Outside Face of Front and Rear Sections	GRATE WIDTH 30″	GRATE WIDTH 31″	GRATE WIDTH 32″	GRATE WIDTH 33″

Boiler Length is Between Outside Face of Front and Rear Sections	GRATE WIDTH 30″		GRATE WIDTH 31″		GRATE WIDTH 32″		GRATE WIDTH 33″	
	Steam	Water	Steam	Water	Steam	Water	Steam	Water
16	232	348	239	358				
18	290	435	299	448				
20	348	522	359	538				
22	406	609	419	629				
24	464	696	479	718				
26	522	784	539	808				
28	580	870	599	898				
30	638	958	659	988	680	1020	702	1053
32	707	1060	732	1098	756	1134	782	1173
34	776	1164	805	1207	832	1248	862	1293
36	845	1267	878	1317	908	1362	942	1413
38	915	1372	951	1426	984	1476	1022	1532
40	985	1477	1024	1535	1060	1590	1102	1653
42	1055	1583	1097	1645	1137	1705	1182	1773
44	1125	1688	1170	1755	1214	1823	1262	1893
46	1195	1793	1243	1864	1291	1935	1343	2014
48	1265	1898	1316	1974	1368	2050	1424	2136
50	1335	2000	1390	2085	1445	2170	1505	2257
52	1425	2140	1484	2225	1543	2315	1607	2410
54	1515	2272	1578	2368	1641	2460	1709	2563
56	1605	2420	1672	2510	1739	2610	1811	2716
58	1695	2542	1766	2650	1837	2760	1913	2869
60	1785	2680	1860	2790	1935	2900	2015	3022
62	1875	2820	1954	2930	2033	3050	2117	3175
64	1965	2950	2048	3070	2131	3195	2219	3328
66	2055	3080	2142	3215	2229	3345	2321	3481
68	2145	3220	2236	3355	2327	3490	2423	3634
70	2235	3350	2320	3480	2425	3640	2525	3787
72	2326	3490	2425	3640	2524	3790	2627	3940
74	2417	3625	2520	3780	2623	3935	2729	4093
76	2508	3760	2615	3920	2722	4085	2832	4248
78	2599	3900	2710	4065	2821	4230	2935	4402
80	2690	4035	2805	4210	2920	4380	3038	4557
82	2755	4130	2873	4310	3005	4505	3120	4680
84	2807	4210	2935	4400	3080	4620	3210	4815
86	2860	4290	2992	4490	3145	4720	3280	4920
88	2907	4360	3045	4570	3200	4800	3350	5025
90	2955	4430	3095	4640	3252	4880	3405	5107
92	3000	4500	3143	4715	3300	4950	3462	5193
94	3043	4565	3188	4780	3338	5007	3517	5275
96	3085	4625	3227	4840	3378	5060	3565	5347
98	3122	4685	3267	4900	3417	5120	3615	5422
100	3160	4740	3305	4955	3452	5180	3665	5497
102	3195	4790	3340	5003	3486	5225	3710	5565
104	3227	4840	3372	5060	3520	5280	3755	5632
106	3255	4880	3403	5104	3552	5330	3792	5688
108	3278	4915	3427	5140	3582	5375	3832	5748
110	3300	4950	3450	5175	3610	5420	3875	5812
112					3637	5455	3910	5865
114					3665	5500	3943	5914
116					3690	5535	3980	5970
118					3715	5575	4010	6015
120					3740	5610	4040	6060
122					3765	5648	4065	6097
124					3785	5680	4095	6142
126					3805	5708	4117	6175
128					3825	5740	4140	6210
130					3845	5765	4162	6243
132					3865	5800	4182	6273
134					3885	5830	4200	6300
136					3900	5850	4220	6330

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Boiler Length is Between Outside Face of Front and Rear Sections	GRATE WIDTH 34″		GRATE WIDTH 35″		GRATE WIDTH 36″		GRATE WIDTH 37″	
	Steam	Water	Steam	Water	Steam	Water	Steam	Water
30	724	1086	746	1119	768	1152	791	1186

Boiler Length is Between Outside Face of Front and Rear Sections	GRATE WIDTH 34″		GRATE WIDTH 35″		GRATE WIDTH 36″		GRATE WIDTH 37″	
	Steam	Water	Steam	Water	Steam	Water	Steam	Water
30	724	1086	746	1119	768	1152	791	1186
32	808	1212	833	1249	859	1288	886	1329
34	892	1338	921	1381	950	1425	981	1471
36	976	1464	1009	1513	1042	1563	1076	1614
38	1060	1590	1097	1645	1134	1701	1171	1756
40	1144	1716	1185	1777	1226	1839	1267	1900
42	1228	1842	1273	1909	1318	1977	1363	2044
44	1312	1968	1361	2041	1410	2115	1457	2185
46	1396	2094	1449	2173	1502	2253	1555	2332
48	1480	2220	1537	2305	1594	2391	1651	2476
50	1565	2347	1625	2437	1686	2529	1747	2620
52	1671	2506	1735	2602	1799	2698	1864	2796
54	1777	2665	1845	2767	1912	2868	1981	2971
56	1883	2824	1955	2932	2026	3039	2098	3147
58	1989	2983	2065	3097	2140	3210	2215	3322
60	2095	3142	2175	3262	2254	3381	2333	3499
62	2201	3301	2285	3427	2368	3552	2451	3676
64	2307	3460	2395	3592	2482	3723	2569	3853
66	2413	3619	2505	3757	2596	3894	2687	4030
68	2519	3778	2615	3922	2710	4065	2805	4207
70	2625	3937	2725	4087	2824	4236	2923	4384
72	2731	4096	2835	4252	2938	4407	3041	4561
74	2837	4255	2945	4417	3052	4578	3159	4738
76	2943	4414	3055	4582	3166	4749	3277	4915
78	3049	4573	3165	4747	3280	4920	3395	5092
80	3156	4734	3275	4912	3394	5091	3513	5269
82	3252	4878	3380	5070	3504	5256	3630	5445
84	3345	5017	3477	5215	3611	5416	3740	5610
86	3426	5139	3567	5350	3715	5575	3848	5772
88	3507	5260	3660	5490	3815	5722	3952	5928
90	3575	5362	3740	5610	3912	5868	4050	6075
92	3642	5463	3820	5730	4005	6007	4150	6225
94	3710	5565	3902	5853	4095	6142	4248	6372
96	3768	5652	3962	5943	4181	6271	4338	6507
98	3830	5745	4045	6067	4264	6396	4425	6637
100	3890	5835	4117	6175	4343	6514	4515	6772
102	3945	5917	4180	6270	4419	6628	4595	6892
104	4000	6000	4245	6367	4492	6738	4680	7020
106	4050	6075	4303	6454	4561	6841	4750	7125
108	4100	6150	4357	6535	4626	6939	4822	7233
110	4147	6220	4417	6625	4688	7032	4895	7342
112	4187	6280	4464	6696	4747	7120	4960	7440
114	4230	6345	4513	6769	4802	7203	5022	7533
116	4272	6408	4563	6844	4854	7281	5087	7630
118	4307	6460	4602	6903	4902	7353	5140	7710
120	4343	6514	4645	6967	4947	7420	5197	7795
122	4373	6559	4680	7020	4988	7482	5248	7872
124	4405	6607	4715	7072	5026	7539	5295	7942
126	4430	6645	4742	7113	5061	7591	5335	8002
128	4455	6682	4772	7158	5092	7638	5375	8062
130	4480	6720	4800	7200	5119	7678	5417	8125
132	4500	6750	4820	7230	5143	7714	5450	8175
134	4520	6780	4840	7260	5164	7746	5483	8224
136	4540	6810	4860	7290	5180	7770	5510	8265

(11-28) First Revision of Page 7—Destroy Original

Boiler Length is Between Outside Face of Front and Rear Sections	GRATE WIDTH 38″		GRATE WIDTH 39″		GRATE WIDTH 40″		GRATE WIDTH 41″	
	Steam	Water	Steam	Water	Steam	Water	Steam	Water
30	814	1221	837	1255	860	1290	886	1329

Boiler Length is Between Outside Face of Front and Rear Sections	GRATE WIDTH 38″		GRATE WIDTH 39″		GRATE WIDTH 40″		GRATE WIDTH 41″	
	Steam	Water	Steam	Water	Steam	Water	Steam	Water
30	814	1221	837	1255	860	1290	886	1329
32	913	1369	940	1410	967	1450	996	1494
34	1012	1518	1043	1564	1074	1611	1106	1659
36	1111	1666	1146	1719	1181	1771	1216	1824
38	1210	1815	1249	1873	1288	1932	1326	1989
40	1309	1963	1352	2028	1395	2092	1436	2154
42	1408	2112	1455	2182	1502	2253	1547	2320
44	1508	2262	1558	2337	1609	2413	1658	2487
46	1608	2412	1661	2491	1716	2574	1769	2653
48	1708	2562	1765	2647	1823	2734	1880	2820
50	1808	2712	1869	2803	1930	2895	1991	2986
52	1929	2893	1994	2991	2059	3088	2124	3186
54	2050	3075	2119	3178	2188	3282	2257	3385
56	2171	3256	2244	3366	2317	3475	2390	3585
58	2292	3438	2369	3553	2446	3669	2523	3784
60	2413	3619	2494	3741	2575	3862	2656	3984
62	2534	3801	2619	3928	2704	4056	2789	4183
64	2656	3984	2744	4116	2833	4249	2922	4383
66	2778	4167	2869	4303	2962	4443	3055	4582
68	2900	4350	2995	4492	3091	4636	3189	4783
70	3022	4533	3121	4681	3220	4830	3323	4984
72	3144	4716	3249	4870	3350	5025	3457	5185
74	3266	4899	3373	5059	3480	5220	3591	5386
76	3388	5082	3499	5248	3610	5415	3725	5587
78	3510	5265	3625	5437	3740	5610	3859	5788
80	3632	5448	3751	5626	3870	5805	3993	5989
82	3750	5625	3875	5812	3997	5995	4130	6195
84	3865	5797	3995	5992	4122	6183	4253	6379
86	3972	5958	4107	6160	4245	6367	4382	6573
88	4087	6130	4225	6337	4365	6547	4505	6757
90	4190	6285	4330	6495	4482	6723	4627	6940
92	4298	6447	4438	6657	4597	6895	4752	7128
94	4402	6603	4545	6817	4710	7065	4820	7230
96	4495	6742	4652	6978	4820	7230	4987	7480
98	4588	6882	4758	7137	4928	7392	5100	7650
100	4685	7027	4860	7290	5033	7549	5212	7818
102	4778	7167	4957	7435	5136	7704	5317	7975
104	4863	7294	5050	7575	5236	7854	5425	8137
106	4947	7420	5140	7710	5334	8001	5530	8295
108	5025	7537	5230	7845	5429	8143	5635	8452
110	5105	7657	5312	7968	5522	8283	5740	8610
112	5177	7765	5392	8088	5612	8418	5840	8760
114	5248	7872	5472	8208	5700	8550	5933	8899
116	5317	7975	5550	8325	5785	8677	6028	9042
118	5385	8077	5625	8437	5868	8802	6117	9175
120	5448	8172	5698	8547	5949	8923	6205	9307
122	5507	8260	5767	8650	6027	9040	6295	9442
124	5565	8347	5833	8749	6102	9153	6380	9570
126	5615	8422	5895	8842	6175	9262	6463	9694
128	5665	8497	5958	8937	6246	9369	6545	9817
130	5715	8572	6015	9022	6314	9471	6617	9925
132	5757	8635	6067	9100	6378	9567	6695	10042
134	5803	8704	6120	9180	6440	9660	6767	10150
136	5840	8760	6170	9255	6500	9750	6840	10260

(11-28) First Revision of Page 8—Destroy Original

Boiler Length is Between Outside Face of Front and Rear Sections	GRATE WIDTH 42″		GRATE WIDTH 43″		GRATE WIDTH 44″		GRATE WIDTH 45″	
	Steam	Water	Steam	Water	Steam	Water	Steam	Water
30	912	1368	939	1408	966	1449	993	1489

Boiler Length is Between Outside Face of Front and Rear Sections	GRATE WIDTH 42″		GRATE WIDTH 43″		GRATE WIDTH 44″		GRATE WIDTH 45″	
	Steam	Water	Steam	Water	Steam	Water	Steam	Water
30	912	1368	939	1408	966	1449	993	1489
32	1026	1539	1056	1584	1086	1629	1117	1675
34	1140	1710	1173	1759	1206	1809	1241	1861
36	1254	1881	1290	1935	1327	1990	1365	2047
38	1368	2052	1407	2110	1448	2172	1489	2233
40	1482	2223	1524	2286	1569	2353	1613	2419
42	1596	2394	1641	2461	1690	2535	1737	2605
44	1710	2565	1759	2638	1811	2716	1861	2791
46	1824	2736	1877	2815	1932	2898	1985	2977
48	1938	2907	1995	2997	2053	3079	2110	3165
50	2052	3078	2113	3169	2174	3261	2235	3352
52	2189	3283	2254	3381	2319	3478	2385	3577
54	2326	3489	2395	3592	2464	3696	2535	3802
56	2463	3694	2536	3804	2609	3913	2685	4027
58	2600	3900	2677	4015	2754	4131	2835	4252
60	2737	4105	2818	4227	2899	4348	2985	4477
62	2874	4311	2960	4440	3044	4566	3135	4702
64	3012	4518	3102	4653	3189	4783	3285	4927
66	3150	4725	3244	4866	3335	5002	3435	5152
68	3288	4932	3386	5079	3481	5221	3585	5377
70	3426	5139	3528	5292	3627	5440	3735	5602
72	3564	5346	3670	5505	3773	5659	3885	5827
74	3702	5553	3812	5718	3920	5880	4035	6052
76	3840	5760	3954	5931	4067	6100	4185	6277
78	3978	5967	4096	6144	4214	6321	4335	6502
80	4116	6174	4239	6358	4362	6543	4486	6729
82	4253	6379	4377	6565	4508	6762	4638	6957
84	4388	6582	4520	6780	4653	6979	4790	7185
86	4520	6780	4658	6987	4796	7194	4937	7405
88	4650	6975	4790	7185	4938	7407	5088	7632
90	4777	7165	4923	7384	5078	7617	5230	7845
92	4908	7362	5062	7593	5217	7825	5373	8059
94	5030	7545	5188	7782	5354	8031	5517	8275
96	5155	7732	5317	7975	5489	8233	5657	8485
98	5275	7912	5450	8175	5623	8434	5797	8695
100	5392	8088	5572	8358	5756	8634	5940	8910
102	5508	8262	5698	8547	5887	8830	6080	9120
104	5625	8437	5820	8730	6016	9024	6211	9316
106	5738	8607	5940	8910	6144	9216	6350	9525
108	5850	8775	6060	9090	6270	9405	6483	9724
110	5960	8940	6125	9187	6394	9591	6612	9918
112	6063	9094	6288	9432	6517	9775	6747	10120
114	6165	9247	6400	9600	6638	9957	6877	10315
116	6270	9405	6515	9772	6757	10135	7001	10501
118	6368	9552	6622	9933	6874	10311	7133	10699
120	6465	9697	6730	10095	6990	10485	7255	10882
122	6565	9847	6835	10252	7104	10656	7379	11068
124	6658	9987	6935	10402	7217	10825	7500	11250
126	6750	10125	7040	10560	7328	10992	7622	11433
128	6842	10263	7140	10710	7438	11157	7742	11613
130	6925	10387	7238	10857	7546	11319	7858	11787
132	7015	10522	7333	10999	7652	11478	7979	11968
134	7095	10642	7425	11137	7757	11635	8103	12154
136	7180	10770	7520	11280	7860	11790	8210	12315

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Boiler Length is Between Outside Face of Front and Rear Sections	GRATE WIDTH 46″		GRATE WIDTH 47″		GRATE WIDTH 48″		GRATE WIDTH 49″	
	Steam	Water	Steam	Water	Steam	Water	Steam	Water
30	1020	1530	1050	1575	1080	1620	1110	1665

Boiler Length is Between Outside Face of Front and Rear Sections	GRATE WIDTH 46″		GRATE WIDTH 47″		GRATE WIDTH 48″		GRATE WIDTH 49″	
	Steam	Water	Steam	Water	Steam	Water	Steam	Water
30	1020	1530	1050	1575	1080	1620	1110	1665
32	1147	1720	1181	1771	1215	1822	1249	1873
34	1274	1911	1312	1968	1350	2025	1388	2082
36	1401	2101	1443	2164	1485	2227	1527	2290
38	1528	2292	1574	2361	1620	2430	1666	2499
40	1656	2484	1705	2557	1755	2632	1805	2707
42	1784	2676	1836	2754	1890	2835	1944	2916
44	1912	2868	1968	2952	2025	3037	2083	3124
46	2040	3060	2100	3150	2161	3241	2222	3333
48	2168	3252	2232	3348	2297	3445	2362	3543
50	2296	3444	2364	3546	2433	3649	2502	3753
52	2450	3675	2522	3783	2595	3892	2668	4002
54	2604	3906	2680	4020	2757	4135	2835	4252
56	2758	4137	2838	4257	2919	4378	3002	4503
58	2912	4368	2996	4494	3081	4621	3169	4753
60	3066	4599	3154	4731	3244	4866	3336	5004
62	3220	4830	3312	4968	3407	5110	3503	5254
64	3374	5061	3470	5205	3570	5355	3670	5505
66	3528	5292	3629	5443	3733	5599	3837	5755
68	3682	5523	3788	5682	3896	5844	4004	6006
70	3836	5754	3947	5920	4059	6088	4171	6256
72	3990	5985	4106	6159	4222	6333	4338	6507
74	4145	6217	4265	6397	4385	6577	4505	6757
76	4300	6450	4424	6636	4548	6822	4672	7008
78	4455	6682	4583	6874	4711	7066	4839	7258
80	4610	6915	4742	7113	4874	7311	5006	7509
82	4770	7155	4901	7351	5036	7554	5180	7770
84	4928	7392	5060	7590	5198	7797	5345	8017
86	5078	7617	5219	7828	5360	8040	5506	8259
88	5243	7864	5375	8062	5521	8281	5720	8580
90	5400	8100	5533	8299	5682	8523	5845	8767
92	5559	8338	5685	8527	5842	8763	6005	9007
94	5700	8550	5842	8763	6002	9003	6180	9270
96	5838	8757	6000	9000	6162	9243	6340	9510
98	5971	8956	6146	9219	6321	9481	6503	9754
100	6117	9175	6300	9450	6480	9720	6617	9925
102	6265	9397	6452	9678	6638	9957	6835	10252
104	6406	9609	6601	9901	6796	10194	6999	10498
106	6550	9825	6755	10132	6953	10429	7165	10747
108	6695	10042	6900	10350	7110	10665	7330	10995
110	6830	10245	7048	10572	7267	10900	7489	11233
112	6970	10455	7195	10792	7423	11134	7657	11485
114	7105	10657	7340	11010	7579	11368	7820	11730
116	7245	10867	7489	11233	7734	11601	7987	11980
118	7385	11077	7642	11463	7889	11833	8155	12232
120	7517	11275	7790	11685	8043	12064	8320	12480
122	7655	11482	7931	11896	8197	12295	8479	12718
124	7785	11677	8070	12105	8351	12526	8645	12967
126	7925	11887	8212	12318	8504	12756	8810	13215
128	8047	12070	8352	12528	9657	12985	8970	13455
130	8175	12262	8490	12735	8809	13213	9130	13695
132	8306	12459	8633	12949	8960	13440	9295	13942
134	8430	12645	8765	13147	9110	13665	9455	14182
136	8560	12840	8910	13365	9260	13890	9620	14430

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Boiler Length is Between Outside Face of Front and Rear Sections	GRATE WIDTH 50″		GRATE WIDTH 51″		GRATE WIDTH 52″		GRATE WIDTH 53″	
	Steam	Water	Steam	Water	Steam	Water	Steam	Water
30	1140	1710	1170	1755				

Boiler Length is Between Outside Face of Front and Rear Sections	GRATE WIDTH 50″		GRATE WIDTH 51″		GRATE WIDTH 52″		GRATE WIDTH 53″	
	Steam	Water	Steam	Water	Steam	Water	Steam	Water
30	1140	1710	1170	1755				
32	1283	1924	1317	1975				
34	1426	2139	1464	2196				
36	1569	2353	1611	2416				
38	1712	2568	1758	2637				
40	1855	2782	1905	2857				
42	1998	2997	2052	3078				
44	2141	3211	2199	3298				
46	2289	3433	2346	3519				
48	2427	3640	2493	3739				
50	2571	3856	2640	3960	2710	4065	2780	4170
52	2742	4114	2815	4222	2889	4333	2963	4444
54	2913	4369	2990	4485	3068	4602	3146	4719
56	3084	4626	3165	4747	3247	4870	3329	4993
58	3255	4882	3340	5010	3426	5139	3512	5268
60	3426	5139	3515	5272	3605	5407	3695	5542
62	3597	5395	3690	5535	3784	5676	3878	5817
64	3768	5652	3865	5797	3963	5944	4062	6093
66	3937	5905	4040	6060	4142	6213	4246	6369
68	4110	6165	4215	6322	4322	6483	4430	6645
70	4281	6421	4390	6585	4502	6753	4614	6921
72	4452	6678	4566	6849	4682	7023	4798	7197
74	4623	6934	4742	7113	4862	7293	4982	7473
76	4794	7191	4918	7377	5042	7563	5166	7749
78	4966	7449	5094	7641	5222	7833	5350	8025
80	5138	7707	5270	7905	5402	8103	5534	8301
82	5313	7969	5455	8182	5582	8373	5720	8580
84	5485	8227	5630	8445	5763	8644	5905	8857
86	5652	8478	5798	8697	5945	8917	6091	9136
88	5828	8742	5980	8970	6128	9192	6282	9423
90	5998	8997	6155	9232	6311	9466	6475	9712
92	6168	9252	6331	9496	6495	9742	6658	9987
94	6325	9487	6515	9872	6679	10018	6850	10275
96	6518	9777	6698	10047	6864	10296	7040	10560
98	6685	10027	6867	10300	7050	10575	7232	10848
100	6863	10294	7053	10579	7236	10854	7430	11145
102	7040	10560	7230	10845	7423	11134	7625	11437
104	7203	10804	7407	11110	7611	11416	7815	11722
106	7378	11067	7585	11377	7799	11698	8018	12027
108	7550	11325	7760	11640	7988	11982	8215	12322
110	7711	11566	7934	11901	8177	12265	8407	12610
112	7890	11835	8125	12187	8367	12550	8615	12922
114	8068	12102	8308	12462	8558	12837	8815	13222
116	8241	12361	8495	12742	8749	13123	9006	13509
118	8415	12622	8680	13020	8941	13411	9210	13815
120	8592	12888	8818	13227	9134	13701	9410	14115
122	8761	13141	9044	13566	9327	13990	9615	14422
124	8942	13413	9230	13845	9521	14281	9815	14722
126	9120	13680	9410	14115	9715	14576	10020	15030
128	9283	13924	9597	14395	9911	14866	10232	15348
130	9465	14197	9782	14673	10106	15159	10445	15667
132	9631	14446	9967	14950	10303	15454	10648	15972
134	9810	14715	10155	15232	10501	15751	10825	16237
136	9980	14970	10340	15510	10700	16050	11070	16605

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Boiler Length is Between Outside Face of Front and Rear Sections	GRATE WIDTH 54″		GRATE WIDTH 55″		GRATE WIDTH 60″		GRATE WIDTH 79″	
	Steam	Water	Steam	Water	Steam	Water	Steam	Water
50	2850	4275	2920	4380	3275	4912	4200	6300
52	3037	4555	3112	4668	3490	5235	4438	6657
54	3224	4836	3304	4956	3705	5557	4676	7014
56	3411	5116	3496	5244	3920	5880	4914	7371
58	3599	5389	3688	5532	4135	6202	5152	7728
60	3787	5680	3880	5820	4350	6525	5390	8085
62	3975	5962	4072	6108	4565	6847	5629	8443
64	4163	6244	4264	6396	4780	7170	5868	8802
66	4351	6526	4456	6684	4995	7492	6107	9160
68	4539	6808	4648	6972	5210	7815	6346	9519
70	4727	7090	4840	7260	5425	8137	6585	9877
72	4915	7372	5032	7548	5640	8460	6824	10236
74	5103	7654	5224	7836	5855	8782	7063	10594
76	5291	7936	5416	8124	6070	9105	7302	10953
78	5479	8218	5608	8412	6285	9427	7541	11311
80	5667	8500	5800	8700	6500	9750	7780	11670
82	5865	8790	5993	8989	6716	10074	8020	12030
84	6060	9090	6188	9282	6935	10402	8261	12391
86	6238	9357	6385	9577	7156	10734	8504	12756
88	6435	9652	6583	9874	7379	11068	8747	13120
90	6625	9937	6783	10174	7604	11406	8992	13488
92	6821	10231	6984	10476	7831	11746	9238	13857
94	7015	10522	7187	10780	8060	12090	9485	14227
96	7218	10827	7392	11089	8290	12435	9734	14601
98	7415	11122	7598	11397	8523	12784	9983	14974
100	7620	11430	7805	11707	8758	13137	10234	15351
102	7820	11730	8014	12021	8995	13492	10486	15729
104	8020	12030	8225	12337	9233	13849	10739	16108
106	8225	12337	8437	12655	9474	14211	10993	16489
108	8430	12645	8651	12976	9716	14574	11248	16872
110	8637	12955	8867	13300	9961	14941	11505	17257
112	8845	13267	9084	13626	10207	15310	11763	17644
114	9050	13575	9302	13953	10456	15684	12022	18033
116	9264	13896	9522	14283	10706	16059	12282	18423
118	9475	14212	9744	14616	10959	16438	12543	18814
120	9685	14527	9967	14950	11213	16819	12805	19207
122	9903	14854	10192	15288	11470	17205	13069	19603
124	10120	15180	10418	15627	11728	17592	13334	20001
126	10335	15502	10646	15969	11988	17982	13599	20398
128	10554	15831	10876	16314	12251	18385	13867	20800
130	10775	16162	11107	16660	12515	18772	14135	21202
132	10993	16489	11339	17008	12781	19171	14405	21607
134	11235	16852	11573	17359	13049	19573	14677	22015
136	11440	17160	11810	17715	13320	19980	14950	22425

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Boiler Length is Between Outside	GRATE WIDTH	GRATE WIDTH	GRATE WIDTH	GRATE WIDTH
	81″			

Boiler Length is Between Outside Face of Front and Rear Sections	GRATE WIDTH		GRATE WIDTH		GRATE WIDTH		GRATE WIDTH	
	81″							
	Steam	Water	Steam	Water	Steam	Water	Steam	Water
50	4330	6495						
52	4570	6855						
54	4810	7215						
56	5050	7575						
58	5290	7935						
60	5530	8295						
62	5770	8655						
64	6010	9015						
66	6250	9375						
68	6490	9735						
70	6730	10095						
72	6970	10455						
74	7210	10815						
76	7450	11175						
78	7690	11535						
80	7930	11895						
82	8171	12256						
84	8413	12619						
86	8656	12984						
88	8900	13350						
90	9145	13717						
92	9392	14088						
94	9640	14460						
96	9889	14833						
98	10139	15208						
100	10390	15585						
102	10642	15963						
104	10896	16344						
106	11151	16726						
108	11407	17110						
110	11665	17497						
112	11924	17886						
114	12185	18277						
116	12447	18670						
118	12710	19065						
120	12974	19461						
122	13239	19858						
124	13505	20257						
126	13773	20659						
128	14042	21063						
130	14312	21468						
132	14583	21874						
134	14855	22282						
136	15130	22695						

PART III
PIPE SIZES

FOREWORD

On Pipe Sizes for Steam Heating Systems and Hot Water Systems

THE selection of proper pipe sizes for steam heating systems has been a perplexing problem to heating engineers and contractors for some years. No uniformity of practice is discernible and of the numerous tables available to the industry many indefinite and variable factors have entered into the calculations with the result that a concerted effort has been made by committees of the HEATING AND PIPING CONTRACTORS NATIONAL ASSOCIATION and the *American Society of Heating and Ventilating Engineers* to study the subject on a scientific basis.

For several years the *American Society of Heating and Ventilating Engineers'* Laboratory has been investigating the flow of steam in pipes and the capacity of pipes for steam heating work with the result that the reports of its Technical Advisory Committee on Pipe Sizes have been used by the HEATING AND PIPING CONTRACTORS NATIONAL ASSOCIATION Committee on Standardization and the *American Society of Heating and Ventilating Engineers* Guide Committee in the compilation of Standard Tables for Pipe Sizes of Steam Heating Systems.

Where data have not been available from research work as in the case of dry returns, standard formulae have been applied so that the user of these tables may feel confident that the values given may be applied with safety.

The information resulting from the cooperative effort of these two organizations it is anticipated will provide engineers and contractors with a standard method for selecting pipe sizes for steam heating systems, that will result in the design of plants that are scientifically correct.

STEAM HEATING PIPE SIZES

The principal factors upon which the determination of pipe sizes for steam heating depends are:

1. The equivalent length of the run from the boiler, or source of steam supply, to the farthest radiator.

2. The total pressure drop, which may be allowed, between the source of supply and the end of the return system.

3. The maximum velocity of steam allowable for quiet and dependable operation of the system.

4. Unusual conditions in the building to be heated.

LENGTH OF RUN

The length of run must not only include the actual linear feet of straight pipe, but also the proper allowance for fittings, valves friction and other items which cause drop in pressure. (See Table 3).

PRESSURE DROP

There are, theoretically, several factors to be considered, including: the initial pressure, the pressure required at the end of the line, fluctuations in the initial pressure, the distance between the low point of steam main and dry return and the water line of the boiler (where the condensation is to be returned by gravity), and any extra load on the system during heating-up periods.

With a high initial pressure it is theoretically possible to allow much greater drops in pressure if there is sufficient distance between the low point of steam main and dry return and the water line of the boiler. In attempting any very great drop in pressure, the following practical difficulties present themselves:

1. If the system is designed to secure the same drop in pressure for each unit of radiation (including those nearest, as well as those farthest from the source of supply) the velocity necessary to equalize these drops in the shorter runs will be so high that serious trouble will be encountered from noise and the entrainment of the condensate.
2. If the system is so designed as not to equalize these pressures, the condensate returning from radiators near the source of supply will be at a correspondingly higher temperature than that from radiators farthest from the source of supply, thus causing re-evaporation and pressures in the return system with consequent backing-up from one radiator to another, the holding-up of the return and the filling of the return lines, with too large a percentage of steam instead of condensate.

It has been found, that while it may be theoretically possible to design a system for relatively large pressure drops, it is generally more satisfactory to design heating systems on the basis of a low initial pressure and reasonably low total drops in pressure. The matter of fluctuations in pressure should be taken into consideration wherever the steam is to be supplied directly from the boiler, to the radiators at boiler pressure and the system should be designed to operate properly with the lowest pressure under which the boiler may operate.

In the matter of initial pressure and return of condensation it is undoubtedly true that with a constant initial pressure (such as is produced by a high pressure supply by means of a pressure reducing valve, or from the boiler direct where the pressure is maintained constant), somewhat higher drops in pressure and correspondingly smaller pipe may be successfully used. It is also undoubtedly true that, with mechanical circulation where a constant vacuum is maintained, fluctuations in initial pressure and the difficulties from high velocities are reduced, so that the pressure drops may be higher and the pipe sizes smaller.

MAXIMUM VELOCITY

The capacity of pipe of a given size in any part of a steam or vapor heating system depends on water of condensation present in, as well as upon the available pressure drop through the pipe. Where no water is present or where a limited quantity flows by gravity in the same direction as the steam the available pressure drop only need be considered.

Where water and steam flow counter to each other the velocity of the steam must not exceed certain values above which disturbance between the counter flowing steam and water may produce objectionable sounds, water hammer, or store water in some parts of the system. The velocity at which such disturbance takes place depends upon the size of the pipe, its location (whether vertical or horizontal), its pitch and the quantity of water flowing counter to the steam.

UNUSUAL CONDITIONS

Under this heading are the character and class of the building, the periodicity of use and the degree of normal temperature to be attained at the beginning of each period of use.

In public buildings, schools, offices, places of assemblage, and such buildings (where the occupants are normally at rest) the building should be heated to its required temperature at the beginning of each period of use. In some buildings (especially offices, schools and public buildings), the time between heating periods is relatively short; whereas in others (such as churches, theaters and places of assemblage), these periods are comparatively long. In other buildings, where the occupants are moving about, it is not always necessary for the building to be heated to the required temperature at the beginning of its period of use. In all cases heat given off by machinery, occupants and illumination, also the heat absorbed by the contents of the building should be taken into account.

All of the pipe sizes on supply and returns are directly and materially affected by reaming or lack of reaming, by sharp turns, elbows and unnecessary fittings and by those various other things which enter into the installation of heating work. However, for the average condition of installation, as practiced today, these figures are apparently safe.

GENERAL DATA ON PIPE SIZE TABLES

The following Tables 1–13 have been compiled for use in designing all type steam heating systems, and may be used, by those experienced in the industry, with satisfactory results. The following general principles should be followed:

1. The initial pressure should not exceed 16 oz. gage.

2. It is recommended that the drop in pressure in the mains and riser to the farthest radiator should not exceed 1 oz. per 100 ft. of straight pipe or its equivalent length, with a lower rate of drop for systems with long runs.

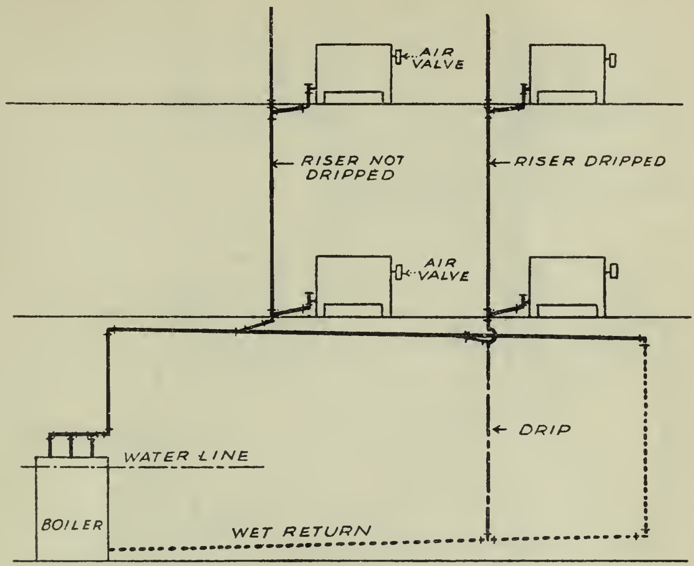
3. In small installations, such as residences, where the longest actual run is seldom over 200 ft. and where the firing periods extend over several hours, resulting in boiler pressure, fluctuating from zero to about 1 lb., the total pressure drop should not exceed 2 oz. for gravity systems. In large buildings, where boilers are under the constant care of a fireman and a uniform pressure is maintained, and where the water line difference will permit, the total drop in pressure may range from 3 to 8 oz. depending upon the equivalent length of the longest run.

4. The total allowable drop in pressure depends upon (*a*) the water line difference, (*b*) the equivalent length of main and riser from the boiler to the farthest radiator, and (c) the regularity of the pressure maintained at the boiler or source of steam supply.

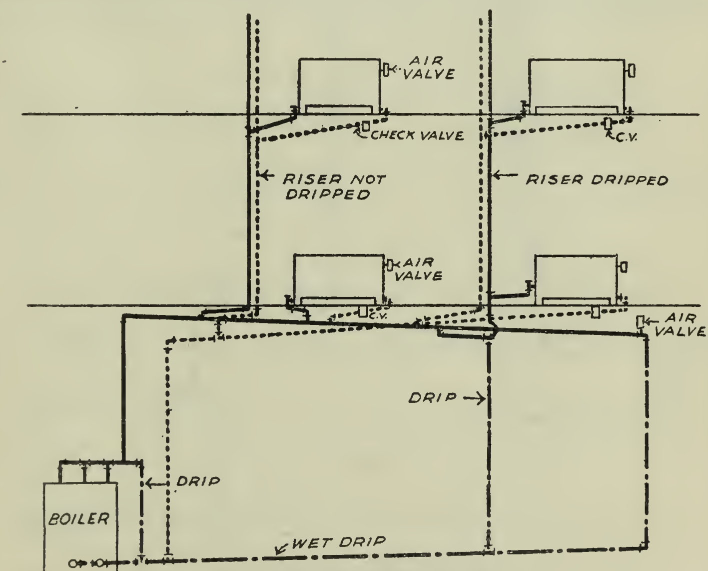
5. The water line difference or distance between the water line of the boiler and the low point of steam main and dry return main should be not less than 24 in., because of the heavy drop in pressure from condensation in heating up a cold system. This difference should be increased 2 in. for every ounce pressure drop in the system. If the total pressure drop were 6 oz., the water line difference should be $6 \times 2 + 24$ or 36 in.

6. There should be a nearly uniform drop in pressure between the source of steam supply and the farthest radiator on every riser. Care should be taken however, to see that the maximum allowable velocity for smooth operation is not exceeded.

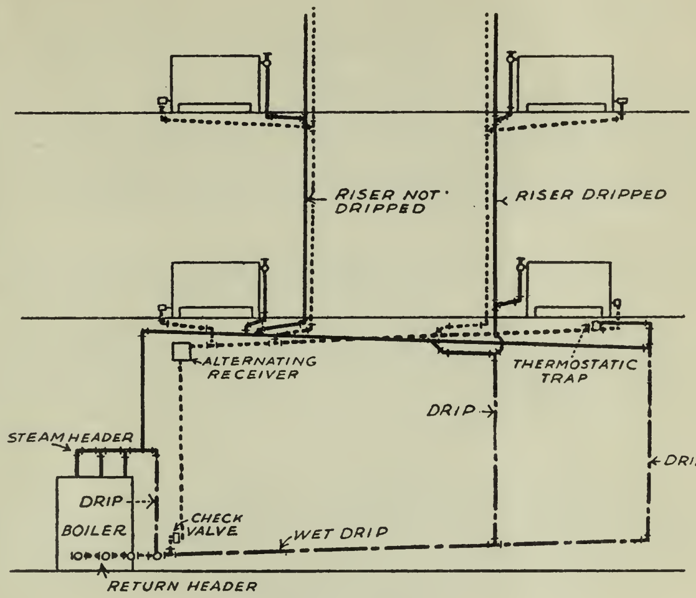
7. In using this method of proportioning a system, care must be exercised to see that no pipe carrying condensate counter to the steam, is loaded to a capacity above the maximum for the particular part of a system in question as shown in Tables 5 to 13.



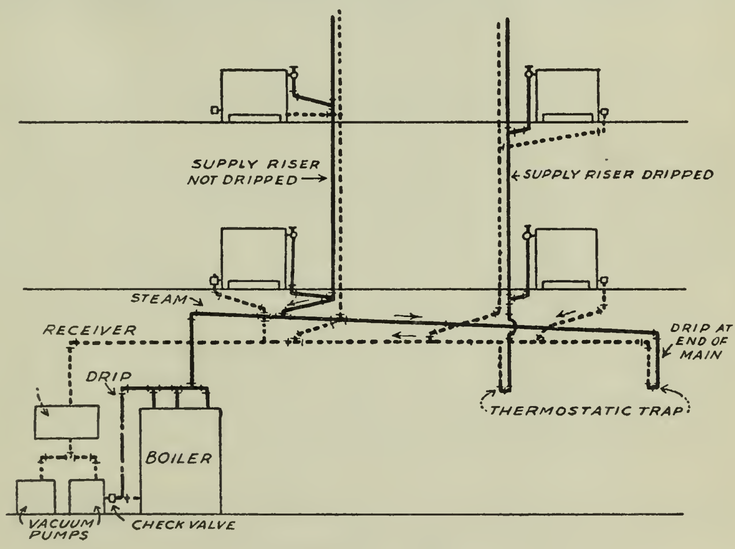
ONE PIPE STEAM SYSTEM



TWO PIPE STEAM SYSTEM



VAPOR SYSTEM



VACUUM SYSTEM

Description of Pipe Size Tables

TABLE 1 gives the numerical value of the four factors of the Babcock formula for various sizes and lengths of pipe and various initial pressures and pressure drops.

Table 2 is a basic table giving the theoretical capacities of pipe in square feet of direct cast iron radiation (Based on ¼ lb. steam per hour per square foot) and the resulting velocity in feet per second for various pressure drops in ounces per 100 ft. length of pipe or equivalent length and with an initial steam pressure of 1 lb. gage.

Table 3 gives the length of pipe in feet to be added to actual length of run to obtain equivalent length.

Table 4 gives constant for calculating the capacity of pipe for steam at initial pressure other than 1 lb. when the capacity at 1 lb. pressure is known; also the constant for calculating capacity of pipe of length other than 100 ft. when capacity of 100 ft. length is known.

Table 5 is a pipe sizing table for small one-pipe gravity low-pressure steam heating systems. This table was designed to meet the requirements of those laying out small systems where the equivalent length of run from the boiler or pressure reducing valve to the farthest radiator is no greater than 200 ft.

Table 6 is for small two-pipe systems, and is similar to Table 5. It gives values for parts of a two-pipe system.

Table 7 is a similar table for small vapor systems.

Tables 8 and 9 were designed for larger one and two-pipe low-pressure gravity steam heating systems, respectively.

Tables 10 and 11 are for sizing pipe for vapor systems where the equivalent length of run exceeds 200 ft. Table 10 is for systems up to 400 ft. equivalent length and is based upon a total pressure drop of 2 oz. from the source of steam supply to the farthest radiator. Table 11 is for larger systems where the equivalent length of run from the boiler or source of steam supply does not exceed 600 ft. It is based upon a total pressure drop of 4 oz.

Table 12 is a pipe sizing table for small vacuum pump systems where the equivalent length of run from the boiler or source of steam supply to the farthest radiator ranges from 100 to 600 ft. The table is based upon a total pressure drop in the entire equivalent length from steam supply to farthest radiator of 4 oz.

Table 13 is similar to Table 12 and is for larger systems where the equivalent length of run ranges up to 1200 ft. It is based on a total pressure drop of 8 oz. in the entire equivalent length.

TABLE 1.

Flow of Steam in Pipes

P = Loss in Pressure in Lbs.
d = Inside Diameter of Pipe in Inches
L = Length of Pipe in Feet
D = Weight of 1 Cu. Ft. of Steam
W = Lbs. of Steam per Min

$$W = 87.0\sqrt{\frac{PDd^5}{\left(1+\frac{3.6}{d}\right)L}}$$

$$P = 0.000132\left(1+\frac{3.6}{d}\right)\frac{W^2L}{Dd^5}$$

Pressure Loss in Ozs.	Col 1 $87.0\sqrt{\frac{P}{100}}$	Pipe Size Nominal	Pipe Size Actual Internal Diameter	Internal Area of Pipe Sq. Ins	Col 2 $\sqrt{\frac{d^5}{1+\frac{3.6}{d}}}$	Steam Press. by Gage	Col 3 $\sqrt{D}$	Length of Pipe in Feet	Col 4 $\sqrt{\frac{100}{L}}$
0.25	1.088	1	1.049	0.864	0.536	-1.0*	0.187	20	2.240
0.50	1.538	1¼	1.380	1.496	1.178	-0.5*	0.190	40	1.580
1.00	2.175	1½	1.610	2.036	1.828	0.0	0.193	60	1.290
2	3.076	2	2.067	3.356	3.710	0.3	0.195	80	1.120
3	3.767	2½	2.469	4.788	6.109	1.3	0.201	100	1.000
4	4.350	3	3.068	7.393	11.183	2.3	0.207	120	0.912
5	4.863	3½	3.548	9.887	16.705	5.3	0.223	140	0.841
6	5.328	4	4.026	12.730	23.631	10.3	0.248	160	0.793
7	5.755	4½	4.506	15.947	32.134	15.3	0.270	180	0.741
8	6.152	5	5.047	20.006	43.719	20.3	0.290	200	0.710
10	6.878	6	6.065	28.886	71.762	30.3	0.326	250	0.632
12	7.534	7	7.023	38.743	106.276	40.3	0.358	300	0.578
14	8.138	8	7.981	50.027	149.382	50.3	0.388	350	0.538
16	8.700	9	8.941	62.786	201.833	60.3	0.415	400	0.500
20	9.727	10	10.020	78.854	272.592	75.3	0.452	450	0.477
24	10.655	12	12.000	113.098	437.503	100.3	0.507	500	0.447
28	11.509	14	13.250	137.880	566.693	125.3	0.567	600	0.407
32	12.304	16	15.250	182.655	816.872	150.3	0.603	700	0.378
40	13.756					175.3	0.645	800	0.354
48	15.069					200.3	0.685	900	0.333
80	19.454							1000	0.316
160	27.512							1200	0.289
320	38.908							1500	0.258
480	47.652							2000	0.224

*1 lb. per sq. in. gage = 2.04 in. Vacuum, Mercury Column.

Table 2. Pressure Loss, Capacity in Square Feet of Equivalent Radiation and Velocity Relationship Based on Table 1, for Various Pressure Drops with 1 Lb. Initial Steam Pressure.

Pressure Loss in Ounces per 100 Ft.	PIPE SIZE													
	1″		1¼″		1½″		2″		2½″		3″		3½″	
	Sq. Ft.	Velocity Ft. per Second	Sq. Ft.	Velocity Ft. per Second	Sq. Ft.	Velocity Ft. per Second	Sq. Ft.	Velocity Ft. per Second	Sq. Ft.	Velocity Ft. per Second	Sq. Ft.	Velocity Ft. per Second	Sq. Ft.	Velocity Ft. per Second
¼	28	7.5	61	9	95	11	193	14	318	17	581	21	869	23
½	39	12	87	15	134	17	273	21	449	24	822	30	1228	33
1	56	17	122	21	190	24	386	31	635	36	1163	42	1737	47
2	79	25	173	30	269	34	546	43	898	50	1645	60	2457	68
3	96	28	212	38	329	42	668	53	1100	62	2014	74	3009	84
4	111	35	245	43	380	49	771	62	1270	72	2326	85	3474	97
5	124	37	274	47	425	55	863	69	1421	80	2600	95	3884	109
6	136	40	300	52	466	59	945	77	1556	88	2848	105	4255	118
7	147	43	324	56	503	66	1020	83	1681	95	3077	113	4596	128
8	157	47	346	61	538	70	1091	89	1797	102	3289	122	4913	136
10	176	52	387	68	601	79	1220	99	2009	114	3677	135	5493	151
12	192	58	424	74	659	87	1336	109	2201	125	4028	148	6017	167
14	208	63	458	80	711	94	1443	118	2377	134	4351	164	6500	180
16	223	70	490	86	760	100	1543	126	2541	144	4651	175	6948	192
20	249	75	548	96	850	112	1806	148	2841	161	5200	196	7768	215
24	273	82	600	106	931	124	1890	154	3113	177	5697	215	8510	238

Pressure Loss in Ounces per 100 Ft.	PIPE SIZE													
	4″		5″		6″		8″		10″		12″		16″	
	Sq. Ft.	Velocity Ft. per Second	Sq. Ft.	Velocity Ft. per Second	Sq. Ft.	Velocity Ft. per Second	Sq. Ft.	Velocity Ft. per Second	Sq. Ft.	Velocity Ft. per Second	Sq. Ft.	Velocity Ft. per Second	Sq. Ft.	Velocity Ft. per Second
¼	1229	26	2273	29	3731	35	7766	42	14,172	48	22,746	52	42,470	62
½	1738	37	3214	41	5276	49	10,983	60	20,043	72	32,168	76	60,061	88
1	2457	52	4546	49	7462	70	15,533	86	28,345	100	45,492	108	84,940	125
2	3475	74	6429	84	10,553	94	21,967	112	40,085	140	64,336	152	121,012	180
3	4256	91	7874	104	12,924	121	26,904	144	49,094	172	78,795	184	147,120	220
4	4914	105	9092	121	14,924	139	31,066	164	56,689	192	90,985	212	169,879	252
5	5494	118	10,165	135	16,685	156	34,733	184	63,380	224	101,724	240	189,937	280
6	6019	128	11,135	148	18,278	168	38,048	204	69,430	244	111,433	264	208,059	308
7	6501	139	12,027	160	19,742	174	41,096	220	74,993	264	120,361	288	224,729	336
8	6950	148	12,858	172	21,105	196	43,934	234	80,171	284	128,672	304	240,245	356
10	7770	166	14,376	193	23,597	216	49,120	268	89,633	312	143,860	340	268,603	400
12	8512	182	15,748	212	25,849	232	53,808	288	98,188	344	157,590	372	294,236	436
14	9194	196	17,009	224	27,920	260	58,120	316	106,056	372	170,217	404	317,815	474
16	9829	211	18,184	234	29,848	276	62,132	340	113,378	394	181,969	428	339,758	508
20	10,989	235	20,331	260	33,371	316	69,466	380	126,768	444	203,448	480	379,861	568
24	12,038	249	22,270	280	36,556	332	76,096	412	138,859	484	222,866	520	416,117	624

Note 1.—Capacities based on ¼ lb. condensation per square foot equivalent radiation—steam and condensation flowing in same direction—actual diameter of standard pipe.

Note 2.—For capacity of pipe with a given pressure drop, in a length other than 100 ft., multiply the capacity in this table for the given pressure per 100 ft. drop by the factor for required length, Column *B*, Table 4.

Note 3.—For capacity with initial pressures other than 1 lb., multiply capacity given in this table by factor for the required initial pressure. Column 2, Table 4.

Note 4.—To determine pressure loss with a given capacity for other lengths of pipe than 100 ft., multiply pressure loss given in this table for the given capacity by the required length of pipe and divide by 100.

Note 5.—Extra length to be added to straight run of pipe, for various fittings and valves to determine equivalent length. (See Table 3.)

Table 3. Length in Feet of Pipe to be Added to Actual Length of Run to Obtain Equivalent Length

Size of Pipe	Std. Elbow	Side Outlet Tee	Gate Valve	Globe Valve	Angle Valve
	Length in Feet to be Added in Run				
2″	5	16	2	18	9
2½″	7	20	3	25	12
3″	10	26	3	33	16
3½″	12	31	4	39	19
4″	14	35	5	45	22
5″	18	44	7	57	28
6″	22	50	9	70	32
7″	26	55	10	82	37
8″	31	63	12	94	42
9″	35	69	13	105	47
10″	39	76	15	118	52
12″	47	90	18	140	63
14″	53	105	20	160	72

Example of length in feet of pipe to be added to actual length of run.

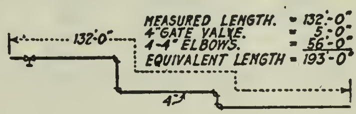


Table 4. Constants for Various Lengths

VARIOUS INITIAL PRESSURES

Steam Pressure Gage Lb.	Constant by Which to Multiply Capacity of any Pipe for 1 Lb. Gage Steam Pressure to Obtain Capacity of Same Pipe for Pressure in Col. 1	Length of Pipe Ft.	Constant by Which to Multiply Capacity of 100 Ft. Pipe to Obtain Capacity of Same Sized Pipe With Same Pressure, and Length as Given in Col. A
Col. 1	Col. 2	Col. A	Col. B
0	0.92	20	2.240
1	1.00	40	1.580
2	1.03	60	1.290
5	1.11	80	1.120
10	1.24	100	1.000
15	1.35	120	0.912
20	1.45	140	0.841
30	1.63	160	0.793
40	1.79	180	0.741
50	1.94	200	0.710
60	2.08	250	0.632
75	2.26	300	0.578
100	2.54	350	0.538
125	2.79	400	0.500
150	3.02	450	0.477
175	3.23	500	0.447
200	3.44	600	0.407
...	....	700	0.378
...	....	800	0.354
...	....	900	0.333
...	....	1000	0.316
...	....	1400	0.267

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

TABLE 5. PIPE SIZES FOR ONE-PIPE, GRAVITY, LOW-PRESSURE STEAM HEATING SYSTEM, WHERE EQUIVALENT LENGTH OF RUN FROM BOILER OR SOURCE OF SUPPLY TO THE FARTHEST RADIATOR DOES NOT EXCEED 200 FT.

Capacity in Sq. Ft. of Equivalent Radiation

Pipe Size Inches	Supply Main Dripped and Branches to Risers Dripped Steam and Condensate flowing in the same direction.	Supply Risers Up-Feed	Branches to Supply Risers and Radiators Not Dripped	Wet Return Main	Dry Return Main	Radiator Valve Sizes and Vertical Connections
A	B	C	D*	E	F	G
¾	....	25	......	......	......	....
1	56	45	20	700	320	20
1¼	122	98	55	1200	670	55
1½	190	152	81	1900	1058	81
2	386	288	165	4000	2300	165
2½	635	464	260	6700	3800	......
3	1163	799	475	10,700	7000	......
3½	1737	1144	745	....	10,000	......
4	2457	1520	1110	....	....	......
5	4546	....	2180	....	....	......
6	7462	....	....	....	....	......

*Radiator branches more than 8 ft. in length should be *one* size larger than shown in Column *D*.

Note 1.—These tables apply where pipes are properly reamed. No allowances for defective material or workmanship have been made.

Note 2.—Capacities based on ¼ lb. condensation per square foot equivalent radiation and actual diameter of standard pipe.

Note 3.—Extra length to be added to straight run of pipe, for various fittings and valves to determine equivalent length. (See Table 3.)

Note 4.—Where it is necessary to drip a steam main, branch to riser or riser, same should be dripped separately into wet return.

Note 5.—Pitch of pipe should be not less than ¼ in. in 10 ft.; on horizontal branches to radiators, at least ½ in. in 10 ft.

[illegible]

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

TABLE 6. PIPE SIZES FOR TWO-PIPE, GRAVITY, LOW PRESSURE STEAM, WHERE EQUIVALENT LENGTH OF RUN FROM BOILER OR SOURCE OF SUPPLY TO FARTHEST RADIATOR DOES NOT EXCEED 200 FT.

Capacity in Sq. Ft. of Equivalent Radiation

PIPE SIZES INCHES	SUPPLY MAIN DRIPPED AND BRANCHES TO RISERS DRIPPED Steam and Condensate Flowing in same Direction	SUPPLY RISERS Up-Feed	BRANCHES TO SUPPLY RISERS AND RADIATORS NOT DRIPPED	RETURN RISERS	WET RETURN MAIN	DRY RETURN MAIN	RADIATOR SUPPLY VALVE	RADIATOR RETURN VALVE
A	*B*	*C*	*D**	*E*	*F*	*G*	*H*	*I*
¾	----	30	----	122	------	------	30	122
1	56	56	26	320	700	320	56	190
1¼	122	122	58	670	1200	670	122	386
1½	190	190	95	1058	1900	1058	190	------
2	386	386	195	2300	4000	2300	386	------
2½	635	635	395	3800	6700	3800	----	------
3	1163	1129	700	7000	10,700	7000	------	------
3½	1737	1548	1150	10,000	---------	10,000	------	------
4	2457	2042	1700	-------	----------	-------	------	------
5	4546	-------	3150	-------	----------	-------	------	------
6	7462	-------	---------	-------	----------	-------	------	------

*Radiator branches more than 8 ft. in length should be *one* size larger than shown in Column *D*.

Note 1.—These tables apply where pipes are properly reamed. No allowances for defective material or workmanship have been made.

Note 2.—Capacities based on ¼ lb. condensation per square foot equivalent radiation and actual diameter of standard pipe.

Note 3.—Extra length to be added to straight run of pipe, for various fittings and valves to determine equivalent length. (See Table 3.)

Note 4.—Where it is necessary to drip a supply main, supply riser or branch to a supply riser, same should be dripped separately into a wet return or through an adequate seal into a dry return. Never drip a supply pipe into a dry return except through an adequate seal.

Note 5.—Pitch of pipe should be not less than ¼ in. in 10 ft.; on horizontal branches to radiators, at least ½ in. in 10 ft.

TABLE 7. PIPE SIZES FOR TWO-PIPE, GRAVITY, VAPOR† SYSTEMS, WHERE EQUIVALENT LENGTH OF RUN FROM BOILER OR SOURCE OF SUPPLY TO FARTHEST RADIATOR DOES NOT EXCEED 200 FT.

Capacity in Sq. Ft. of Equivalent Radiation

Pipe Size Inches	Supply Main Dripped and Branches to Risers Dripped Steam and Condensate flowing in same direction.	Supply Risers Up-Feed	Branches to Supply Risers and Radiators Not Dripped	Return Risers	Wet Return Main	Dry Return Main
A	*B*	*C*	*D**	*E*	*F*	*G*
¾	....	30	....	190	......	......
1	56	56	26	450	700	320
1¼	122	122	58	990	1200	670
1½	190	190	95	1500	1900	1058
2	386	386	195	3000	4000	2300
2½	635	635	395	....	6700	3800
3	1163	1129	700	....	10,700	7000
3½	1737	1548	1150	....	....	10,000
4	2457	2042	1700	....	....	....
5	4546	....	3150	....	....	....
6	7462	Different makes of supply and return valves, steam traps and other specialties vary as to capacity, therefore use size as recommended for any particular make. Vertical connections to be of same size as valve and trap used. Return horizontal runout to be not less than ¾ in.				

*Radiator branches more than 8 ft. in length should be *one* size larger than shown in Column *D*.

†This table is for systems which are open to atmosphere or operate under slight pressure or partial vacuum without use of vacuum pumps.

Note 1.—These tables apply where pipes are properly reamed. No allowances for defective material or workmanship have been made.

Note 2.—Capacities based on ¼ lb. condensation per square foot equivalent radiation and actual diameter of standard pipe.

Note 3.—Extra length to be added to straight run of pipe, for various fittings and valves to determine equivalent length. (See Table 3.)

Note 4.—Where it is necessary to drip a supply main, supply riser or branch to a supply riser, same should be dripped separately into a wet return. The drip for a vapor or vacuum system may be taken into a dry return through a steam trap.

Note 5.—Pitch of pipe should be not less than ¼ in. in 10 ft.; on horizontal branches to radiators, at least ½ in. in 10 ft.

Table 8. Pipe Sizes for One-Pipe, Gravity, Low Pressure Steam Heating Systems, where Equivalent Length of Run from Boiler or Source of Supply to Farthest Radiator Exceeds 200 ft.

Capacity in Sq. Ft. of Equivalent Radiation

Pipe Size Inches	Equivalent Length of Pipe from Boiler to Farthest Radiator, Including Main and Riser. (See *Note 4*.) Supply Main Dripped and Branches to Risers Dripped—Steam and Condensate flowing in same direction. Based on 4 oz. Total Pressure Drop						Maximum Capacities		
	100 Ft.	200 Ft.	300 Ft.	400 Ft.	500 Ft.	600 Ft.	Supply Risers Up-Feed	Branches to Supply Risers and Radiators Not Dripped	Radiator Valves and Vertical Connections
A	B	C	D	E	F	G	H	I*	J
1	111	79	65	56	49	46	45	20	20
1¼	245	173	141	122	110	100	98	55	55
1½	380	269	220	190	165	155	152	81	81
2	771	546	446	386	345	315	288	165	165
2½	1270	898	734	635	568	518	464	260	......
3	2326	1645	1342	1163	1040	948	799	475	......
3½	3474	2457	2006	1737	1552	1419	1144	745	......
4	4914	3475	2828	2457	2196	2011	1520	1110	......
5	9092	6429	5250	4546	4062	3712	....	2180	......
6	14,924	10,553	8618	7462	6669	6094	....	....	......
8	31,066	21,967	17,935	15,533	13,880	12,682	....	....	......
10	56,689	40,085	32,730	28,345	25,334	23,144	....	....	......
12	90,985	64,336	52,530	45,492	40,660	37,145	....	....	......

Pipe Size Inches	Dry Return Main — Equivalent Length of Run from Boiler to Foot of Farthest Riser in Feet						Wet Return Main — Equivalent Length of Run from Boiler to Foot of Farthest Riser in Feet					
	100	200	300	400	500	600	100	200	300	400	500	600
K	L	M	N	O	P	Q	R	S	T	U	V	W
1	460	412	368	320	322	275	1400	1000	820	700	640	580
1¼	962	868	770	670	579	480	2400	1700	1390	1200	1080	990
1½	1512	1362	1210	1058	909	757	3800	2700	2180	1900	1710	1570
2	3300	2960	2640	2300	1980	1630	8000	5600	4520	4000	3560	3240
2½	5450	4900	4380	3800	3300	2770	13,400	9400	7600	6700	6000	5300
3	10,000	9000	8000	7000	6000	5000	21,400	15,000	12,500	10,700	9400	8590
3½	14,300	12,900	11,500	10,000	8600	7200	32,000	22,000	18,500	16,000	14,400	13,200
4	21,500	19,300	17,200	15,000	12,900	10,700	44,000	31,000	25,500	22,000	19,900	18,300

*Radiator branches more than 8 ft. in length should be *one* size larger than shown in Column *I*.

Note 1.—These tables apply where pipes are properly reamed. No allowances for defective material or workmanship have been made.

Note 2.—Capacities based on ¼ lb. condensation per square foot equivalent radiation and actual diameter of standard pipe.

Note 3.—Extra length to be added to straight run of pipe, for various fittings and valves to determine equivalent length. (See Table 3.)

Note 4.—Mains are to be proportioned according to the equivalent length of run from the boiler or source of supply to the farthest radiators supplied by the main.

Determine equivalent length of run then use figures in that corresponding Column (*B* to *G*) for supply mains; (*L to Q*) for dry return mains; (*R* to *W*) for wet return mains for sizing the entire run.

Risers are to be proportioned according to the equivalent length of run from the boiler or source of supply to the farthest radiator on each particular riser.

Determine the distance to the farthest radiator then use the figures in the corresponding Column (*B* to *G*) for sizing each riser; providing the amount of radiation for that riser does not exceed amounts shown in Column *H*. Where riser capacities are found to be in excess of amounts in Column *H*, step up to necessary size indicated in that column.

Note 5.—Where it is necessary to drip a steam main, branch to riser or riser same should be dripped separately into wet return.

Note 6.—Pitch of pipe should be not less than ¼ in. in 10 ft.; on horizontal branches to radiators at least ½ in. in 10 ft.

Table 9. Pipe Sizes for Two-Pipe, Gravity, Low Pressure Steam Heating Systems where Equivalent Length of Run from Boiler or Source of Supply to Farthest Radiator Exceeds 200 Ft.

Capacity in Sq. Ft. of Equivalent Radiation

Pipe Size Inches	Equivalent Length of Pipe from Boiler to Farthest Radiator, Including Main and Riser. (See *Note 4*.) Supply Main Dripped and Branches to Risers Dripped—Steam and Condensate flowing in same direction. Based on 4 oz. Total Pressure Drop						Maximum Capacities			
	100 Ft.	200 Ft.	300 Ft.	400 Ft.	500 Ft.	600 Ft.	Supply Risers Up-Feed	Branches to Supply Risers and Radiators Not Dripped	Rad. Supply Valves and Vertical Connections	Radiator Return Valves and Connections
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I**	*J*	*K*
¾	......	....	....	....	....	....	30	....	30	122
1	111	79	65	56	49	46	56	26	56	190
1¼	245	173	141	122	110	100	122	58	122	386
1½	380	269	220	190	165	155	190	95	190	......
2	771	546	446	386	345	315	386	195	386	......
2½	1270	898	734	635	568	518	635	395	......	......
3	2326	1645	1342	1163	1040	948	1129	700	......	......
3½	3474	2457	2006	1737	1552	1419	1548	1150	......	......
4	4914	3475	2828	2457	2196	2011	2042	1700	......	......
5	9092	6429	5250	4546	4062	3712	....	3150	......	......
6	14,924	10,553	8618	7462	6669	6094	....	....	......	......
8	31,066	21,967	17,935	15,533	13,880	12,682	....	....	......	......
10	56,689	40,085	32,730	28,345	25,334	23,144	....	....	......	......
12	90,985	64,336	52,530	45,492	40,660	37,145	....	....	......	......

Pipe Size Inches	Dry Return Main — Equivalent Length of Run from Boiler to Farthest Radiator in Feet						Wet Return Main — Equivalent Length of Run from Boiler to Farthest Radiator in Feet					
	100	200	300	400	500	600	100	200	300	400	500	600
M	*N*	*O*	*P*	*Q*	*R*	*S*	*T*	*U*	*V*	*W*	*X*	*Y*
1	460	412	368	320	322	275	1400	1000	820	700	640	580
1¼	962	868	770	670	579	480	2400	1700	1390	1200	1080	990
1½	1512	1362	1210	1058	909	757	3800	2700	2180	1900	1710	1570
2	3300	2960	2640	2300	1980	1630	8000	5600	4520	4000	3460	3240
2½	5450	4900	4380	3800	3300	2770	13,400	9400	7600	6700	6000	5300
3	10,000	9000	8000	7000	6000	5000	21,400	15,000	12,500	10,700	9400	8500
3½	14,300	12,900	11,500	10,000	8600	7200	32,000	22,000	18,500	16,000	14,400	13,200
4	21,500	19,300	17,200	15,000	12,900	10,700	44,000	31,000	25,500	22,000	19,900	18,300

* Radiator branches more than 8 ft. in length should be *one* size larger than shown in Column *I*.

Note 1.—These tables apply where pipes are properly reamed. No allowances for defective material or workmanship have been made.

Note 2.—Capacities based on ¼ lb. condensation per square foot equivalent radiation and actual diameter of standard pipe.

Note 3.—Extra length to be added to straight run of pipe, for various fittings and valves to determine equivalent length. (See Table 3.)

Note 4.—Mains are to be proportioned according to the equivalent length of run from the boiler or source of supply to the farthest radiators supplied by the main.

Determine equivalent length of run, then use figures in that corresponding Column (*B* to *G*) for supply mains; (*N* to *S*) for dry return mains; (*T* to *Y*) for wet return mains; for sizing the entire run.

Risers are to be proportioned according to the equivalent length of run from the boiler or source of supply to the farthest radiator or on each particular riser.

Determine the distance to the farthest radiator, then use the figures in the corresponding Column (*B* to *G*) for sizing each riser; providing the amount of radiation for that riser does not exceed amounts shown in Column *H*. Where riser capacities are found to be in excess of amounts in Column *H*, step up to necessary size indicated in that column.

Note 5.—Where it is necessary to drip a supply main or a supply riser or a branch to a supply riser, same should drip separately into a wet return. A drip for a two-pipe system may be taken into a dry return through an adequate seal.

Note 6.—Pitch of pipe should be not less than ¼ in. in 10 ft.; on horizontal branches to radiators at least ½ in. in 10 ft.

Table 10. Pipe Sizes for Two-Pipe Vapor† Heating Systems, where Equivalent Length of Run from Boiler or Source of Supply to Farthest Radiator Exceeds 200 Ft.

Capacity in Sq. Ft. of Equivalent Radiation

Pipe Size Inches	Equivalent Length of Pipe from Boiler to Farthest Radiator, Including Main and Riser. (See *Note 4.*) Supply Main Dripped and Branches to Risers Dripped—Steam and Condensate flowing in same direction. Based on 2 oz. Total Pressure Drop				Maximum Capacities		
	100 Ft.	200 Ft.	300 Ft.	400 Ft.	Supply Risers Up-Feed	Branches to Supply Risers and Radiators Not Dripped	Return Risers
A	*B*	*C*	*D*	*E*	*F*	*G**	*H*
¾	....	....	....	....	30	....	190
1	79	56	46	39	56	26	450
1¼	173	122	100	87	122	58	990
1½	269	190	155	134	190	95	1500
2	546	386	315	273	386	195	3000
2½	898	635	518	449	635	395	......
3	1645	1163	948	822	1129	700	....
3½	2457	1737	1419	1228	1548	1150	....
4	3475	2457	2011	1738	2042	1700	....
5	6929	4546	3712	3214	....	3150	....
6	10,553	7462	6094	5276	Different makes of supply and return valves, steam traps and other specialties vary as to capacity, therefore use size as recommended for any particular make. Vertical connections to be of same size as valve and trap used. Return horizontal runout to be not less than ¾ in.		
8	21,967	15,533	12,682	10,983			
10	40,085	23,345	23,144	20,043			
12	64,336	45,492	37,145	32,168			

Pipe Size Inches	Dry Return Main — Equivalent Length of Run from Boiler to Farthest Radiator in Feet				Wet Return Main — Equivalent Length of Run from Boiler to Farthest Radiator in Feet			
	100	200	300	400	100	200	300	400
I	*J*	*K*	*L*	*M*	*N*	*O*	*P*	*Q*
1	355	320	285	248	1000	700	580	500
1¼	745	670	595	520	1700	1200	990	850
1½	1173	1058	943	822	2700	1900	1570	1350
2	2680	2300	2140	1880	5600	4000	3240	2800
2½	4300	3800	3470	3040	9400	6700	5300	4700
3	7800	7000	6250	5480	15,000	10,700	8500	7500
3½	11,100	10,000	8800	7880	22,000	16,000	13,200	11,000
4	16,700	15,000	13,400	11,700	31,000	22,000	18,300	15,500

* Radiator branches more than 8 ft. in length should be *one* size larger than shown in Column *G*.
† This table is for systems which are open to atmosphere or operate under slight pressure or partial vacuum without use of vacuum pumps.

Note 1.—These tables apply where pipes are properly reamed. No allowances for defective material or workmanship have been made.

Note 2.—Capacities based on ¼ lb. condensation per square foot equivalent radiation and actual diameter of standard pipe.

Note 3.—Extra length to be added to straight run of pipe, for various fittings and valves to determine equivalent length. (See Table 3.)

Note 4.—Mains are to be proportioned according to the equivalent length of run from the boiler or source of supply to the farthest radiators supplied by the main.

Determine equivalent length of run, then use figures in corresponding Column (*B* to *E*) for supply mains; (*J* to *M*) for dry return mains; (*N* to *Q*) for wet return mains for sizing the entire run.

Risers are to be proportioned according to the equivalent length of run from the boiler or source of supply to the farthest radiator on each riser.

Determine the distance to the farthest radiator, then use the figures in the corresponding Column (*B* to *E*) for sizing each riser; providing the amount of radiation for that riser does not exceed amounts shown in Column *F*. Where riser capacities are found to be in excess of amounts shown in Column *F*, step up to necessary size indicated in that column.

Note 5.—Where it is necessary to drip a supply main or a supply riser or a branch to a supply riser, same should drip separately into a wet return. The drip for a vapor or vacuum system may be taken into a dry return through a steam trap.

Note 6.—Pitch of pipe should be not less than ¼ in. in 10 ft.; on horizontal branches to radiators at least ½ in. in 10 ft.

TABLE 11. PIPE SIZES TABLE FOR TWO-PIPE VAPOR† HEATING SYSTEMS, WHERE EQUIVALENT LENGTH OF RUN FROM BOILER OR SOURCE OF SUPPLY TO FARTHEST RADIATOR EXCEEDS 200 FT.

Capacity in Sq. Ft. of Equivalent Radiation

Pipe Size Inches	Equivalent Length of Pipe from Boiler to Farthest Radiator, Including Main and Riser. (See *Note 4*) Supply Main Dripped and Branches to Risers Dripped—Steam and Condensate flowing in same direction. Based on 4 oz. Total Pressure Drop						Maximum Capacities		
	100 Ft.	200 Ft.	300 Ft.	400 Ft.	500 Ft.	600 Ft.	Supply Risers Up-Feed	Branches to Supply Risers and Radiators Not Dripped	Return Risers
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I**	*J*
¾	......	....	....	....	....	....	30	....	190
1	111	79	65	56	49	46	56	26	450
1¼	245	173	141	122	110	100	122	58	990
1½	380	269	220	190	165	155	190	95	1500
2	771	546	446	386	345	315	386	195	3000
2½	1270	898	734	635	568	518	635	395	....
3	2326	1645	1342	1163	1040	948	1129	700	....
3½	3474	2457	2006	1737	1552	1419	1548	1150	....
4	4914	3475	2828	2457	2196	2011	2042	1700	....
5	9092	6429	5250	4546	4062	3712	....	3150	....
6	14,924	10,553	8618	7462	6669	6094	Different makes of supply and return valves, steam traps and other specialties vary as to capacity, therefore use size as recommended for any particular make. Vertical connections to be of same size as valve and trap used. Return horizontal runout to be not less than ¾ in.		
8	31,066	21,967	17,935	15,533	13,880	12,682			
10	56,689	40,085	32,730	28,345	25,334	23,144			
12	90,985	64,336	52,530	45,492	40,660	37,145			

Pipe Size Inches	Dry Return Main — Equivalent Length of Run from Boiler to Farthest Radiator in Feet						Wet Return Main — Equivalent Length of Run from Boiler to Farthest Radiator in Feet					
	100	200	300	400	500	600	100	200	300	400	500	600
K	*L*	*M*	*N*	*O*	*P*	*Q*	*R*	*S*	*T*	*U*	*V*	*W*
1	460	412	368	320	322	275	1400	1000	820	700	590	600
1¼	962	868	770	670	579	480	2400	1700	1420	1200	1020	860
1½	1512	1362	1210	1058	909	757	3800	2700	2260	1900	1560	1300
2	3300	2960	2640	2300	1980	1630	8000	5600	4500	4000	3360	2800
2½	5450	4900	4380	3800	3300	2770	13,400	9400	7600	6700	5700	4800
3	10,000	9000	8000	7000	6000	5000	21,400	15,000	12,300	10,700	9300	7800
3½	14,300	12,900	11,500	10,000	8600	7200	32,000	22,000	24,000	16,000	13,600	11,400
4	21,500	19,300	17,200	15,000	12,900	10,700	44,000	31,000	26,000	22,000	20,500	15,400

*Radiator branches more than 8 ft. in length should be *one* size larger than shown in Column *I*.

†This table is for systems which are open to atmosphere or operate under slight pressure or partial vacuum without use of vacuum pumps.

Note 1.—These tables apply where pipes are properly reamed. No allowances for defective material or workmanship have been made.

Note 2.—Capacities based on ¼ lb. condensation per square foot equivalent radiation and actual diameter of standard pipe.

Note 3.—Extra length to be added to straight run of pipe, for various fittings and valves to determine equivalent length. (See Table 3.)

Note 4.—Mains are to be proportioned according to the equivalent length of run from the boiler or source of supply to the farthest radiators supplied by the main.

Determine equivalent length of run then use figures in that corresponding Column [(*B* to *G*) for supply mains; (*L* to *Q*) for dry return mains; (*R* to *W*) for wet return mains] for sizing the entire run.

Risers are to be proportioned according to the equivalent length of run from the boiler or source of supply to the farthest radiator on each riser.

Determine the distance to the farthest radiator then use the figures in the corresponding Column (*B* to *G*) for sizing each riser; providing the amount of radiation for that riser does not exceed amounts shown in Column *H*. Where riser capacities are found to be in excess of amounts shown in Column *H*, step up to necessary size indicated in that column.

Note 5.—Where it is necessary to drip a supply main or a supply riser or a branch to a supply riser, same should drip separately into a wet return. The drip for a vapor or a vacuum system may be taken into a dry return through a steam trap.

Note 6.—Pitch of pipe should be not less than ¼ in. in 10 ft.; on horizontal branches to radiators at least ½ in. in 10 ft.

Table 12. Pipe Sizes Table for Vacuum Pump Systems, where Equivalent Length of Run from Boiler or Source of Supply to Farthest Radiator Exceeds 200 Ft.

Capacity in Sq. Ft. of Equivalent Radiation

Pipe Size Inches	Equivalent Length of Pipe from Boiler to Farthest Radiator, Including Main and Riser. (See *Note 4.*) Supply Main Dripped and Branches to Risers Dripped—Steam and Condensate flowing in same direction. Based on 4 oz. Total Pressure Drop**						Maximum Capacities	
	100 Ft.	200 Ft.	300 Ft.	400 Ft.	500 Ft.	600 Ft.	Supply Risers Up-Feed	Branches to Supply Risers and Radiators Not Dripped
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I**
¾	......	....	....	....	....	.....	....	....
1	111	79	65	56	49	46	56	26
1¼	245	173	141	122	110	100	122	58
1½	380	269	220	190	165	155	190	95
2	771	546	446	386	345	315	386	195
2½	1270	898	734	635	568	518	635	395
3	2326	1645	1342	1163	1040	948	1129	700
3½	3474	2457	2006	1737	1552	1419	1548	1150
4	4914	3475	2828	2457	2196	2011	2042	1700
5	9092	6429	5250	4546	4062	3712		3150
6	14,924	10,553	8618	7462	6669	6094	....	....
8	31,066	21,967	17,935	15,533	13,880	12,682	....	....
10	56,689	40,085	32,730	28,345	25,334	23,144	....	....
12	90,985	64,336	52,530	45,492	40,660	37,145	....	....

Pipe Size Inches		Return Mains and Risers					
Riser	Main	100 Ft	200 Ft.	300 Ft.	400 Ft.	500 Ft.	600 Ft.
J	*K*	*L*	*M*	*N*	*O*	*P*	*Q*
....	¾	800	568	462	400	358	326
¾	1	1400	994	810	700	626	570
1	1¼	2400	1704	1387	1200	1073	976
1¼	1½	3800	2696	2195	1900	1698	1547
1½	2	8000	5680	4622	4000	3575	3256
2	2½	13,400	9510	7745	6700	5990	5453
2½	3	21,400	15,190	12,360	10,700	9565	8710
3	3½	32,000	22,710	18,490	16,000	14,300	13,020
3½	4	44,000	31,220	25,430	22,000	19,660	17,910

Different makes of supply and return valves, steam traps and other specialties vary as to capacity, therefore use size as recommended for any particular make. Vertical connection to be of same size as valve and trap used. Return horizontal runout to be no less than ¾ in.

* Radiator branches more than 8 ft. in length should be *one* size larger than shown in Column *I*.

** It is not generally considered good practice to greatly exceed 1 oz. drop in pressure in each 100 ft. equivalent length of run nor to exceed 1 lb. total pressure drop in any system.

Note 1.—These tables apply where pipes are properly reamed. No allowances for defective material or workmanship have been made.

Note 2.—Capacities based on ¼ lb. condensation per square foot equivalent radiation and actual diameter of standard pipe.

Note 3.—Extra length to be added to straight run of pipe, for various fittings and valves to determine equivalent length. (See Table 3.)

Note 4.—Mains are to be proportioned according to the equivalent length of run from the boiler or source of supply to the farthest radiators supplied by the main.

Determine equivalent length of run, then use figures in corresponding Column (*B* to *G*) for sizing the entire run.

Supply risers are to be proportioned according to the equivalent length of run from the boiler or source of supply to the farthest radiator on each riser. Determine the distance to the farthest radiator then use figures in that corresponding Column (*B* to *G*) for sizing each riser; providing the amount of radiation for that riser does not exceed amounts shown in Column *H*. Where riser capacities are found to be in excess of amounts shown in Column *H*, step up to necessary size indicated in that column.

Note 5.—Return mains and risers are to be proportioned according to the equivalent distance in feet, from farthest radiator to the vacuum pump; using capacities in that corresponding Column (*L* to *Q*) for sizing entire return riser (Column *J*) and return main (Column *K*).

Note 6.—Where it is necessary to drip a supply main, supply riser or branch to a supply riser, same should be dripped separately through a steam trap into vacuum return. Never drip a supply riser into a vacuum return except through a steam trap.

Note 7.—Pitch of pipe should be not less than ¼ in. in 10 ft.; on horizontal branches to radiators, at least ½ in. in 10 ft.

TABLE 13. PIPE SIZES FOR VACUUM PUMP SYSTEMS, WHERE EQUIVALENT LENGTH OF RUN FROM BOILER OR SOURCE OF SUPPLY TO FARTHEST RADIATOR EXCEEDS 200 FT.

Capacity in Sq. Ft. of Equivalent Radiation

Pipe Size In.	Equivalent Length of Pipe from Boiler to Farthest Radiator, Including Main and Riser. (See *Note 4.*) Supply Main Dripped and Branches to Risers Dripped—Steam and Condensate flowing in same direction. Based on 8 oz. Total Pressure Drop**									Maximum Capacities	
	100 Ft.	200 Ft.	300 Ft.	400 Ft.	500 Ft.	600 Ft.	800 Ft.	1000 Ft.	1200 Ft.	Supply Risers Up-Feed	Branches to Supply Risers and Radiators Not Dripped
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*K*	*L**
1	157	111	92	79	70	65	56	49	46	56	26
1¼	346	245	200	173	154	141	122	110	100	122	58
1½	538	380	310	269	240	220	190	165	155	190	95
2	1091	771	630	546	487	446	386	345	315	386	195
2½	1797	1270	1036	898	803	734	635	568	518	635	395
3	3289	2326	1896	1645	1470	1342	1163	1040	948	1129	700
3½	4913	3474	2838	2457	2196	2006	1737	1552	1419	1548	1150
4	6950	4914	4022	3475	3106	2828	2457	2196	2011	2042	1700
5	12,858	9092	7424	6429	5747	5250	4546	4062	3712	....	3150
6	21,105	14,924	12,168	10,553	9433	8618	7462	6669	6084	....	....
8	43,934	31,066	25,364	21,967	19,638	17,935	15,533	13,880	12,682	....	....
10	80,171	56,689	46,288	40,085	35,836	32,730	28,345	25,334	23,144	....	....
12	128,672	90,985	74,290	64,336	57,516	52,530	45,492	40,660	37,145	....	....
16	240,245	169,879	138,381	121,012	107,389	98,500	84,849	75,917	69,671	....	....

Pipe Size Inches		Return Mains and Risers								
Riser	Main	100 Ft.	200 Ft.	300 Ft.	400 Ft.	500 Ft.	600 Ft.	800 Ft.	1000 Ft.	1200 Ft.
M	*N*	*O*	*P*	*Q*	*R*	*S*	*T*	*U*	*V*	*W*
....	¾	1130	800	653	568	505	462	400	358	326
¾	1	1977	1400	1143	994	884	810	700	626	570
1	1¼	3390	2400	1960	1704	1515	1387	1200	1073	976
1¼	1½	5370	3800	3103	2696	2400	2195	1900	1698	1547
1½	2	11,300	8000	6533	5680	5050	4622	4000	3575	3256
2	2½	18,925	13,400	10,940	9,510	8460	7745	6700	5990	5453
2½	3	30,230	21,400	17,460	15,190	13,510	12,360	10,700	9,565	8,710
3	3½	45,200	32,000	26,130	22,710	20,200	18,490	16,000	14,300	13,020
3½	4	62,180	44,000	35,950	31,220	27,800	25,430	22,000	19,660	17,910
4	5	109,300	77,400	63,200	54,920	48,800	44,720	38,700	34,600	31,500
5	6	175,100	124,000	101,200	88,000	78,200	71,700	62,000	55,410	50,450

Different makes of supply and return valves, steam traps and other specialties vary as to capacity, therefore use size as recommended for any particular make. Vertical connection to be of same size as valve and trap used. Return horizontal runout to be not less than ¾ in.

* Radiator branches more than 8 ft. in length should be *one* size larger than shown in Column *L*.
** It is not generally considered good practice to greatly exceed 1 oz. drop in pressure in each 100 ft., equivalent length of run nor to exceed 1 lb. total pressure drop in any system.

Note 1.—These tables apply where pipes are properly reamed. No allowances for defective material or workmanship have been made.

Note 2.—Capacities based on ¼ lb. condensation per square foot equivalent radiation and actual diameter of standard pipe.

Note 3.—Extra length to be added to straight run of pipe, for various fittings and valves to determine equivalent length. (See Table 3.)

Note 4.—Mains are to be proportioned according to the equivalent length of run from the boiler or source of supply to the farthest radiators supplied by the main.

Determine equivalent length of run, then use figures in corresponding Column (*B* to *J*) for sizing the entire run.

Supply risers are to be proportioned according to the equivalent length of run from the boiler or source of supply to the farthest radiator on each particular riser. Determine the distance to the farthest radiator, then use figures in that corresponding Column (*B* to *J*) for sizing each riser; providing the amount of radiation for that riser does not exceed amounts shown in Column *K*. Where riser capacities are found to be in excess of amounts shown in Column *K*, step up to necessary size indicated in that column.

Note 5.—Return mains and risers are to be proportioned according to the equivalent distance in feet, from farthest radiator to the vacuum pump; using capacities in that corresponding Column (*O* to *W*) for sizing entire return riser (Column *M*) and return main (Column *N*).

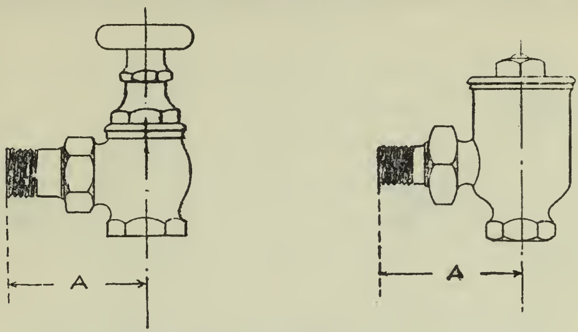
Note 6.—Where it is necessary to drip a supply main, supply riser or branch to a supply riser, same should be dripped separately through a steam trap into vacuum return. Never drip a supply riser into a vacuum return except through a steam trap.

Note 7.—Pitch of pipe should be not less than ¼ in. in 10 ft.; on horizontal branches to radiators, at least ½ in. in 10 ft.

PART IV

STANDARD DIMENSIONS OF VALVES AND FITTINGS AND MATERIALS

(4-29) First Revision. Part IV, Page 1—Destroy Original

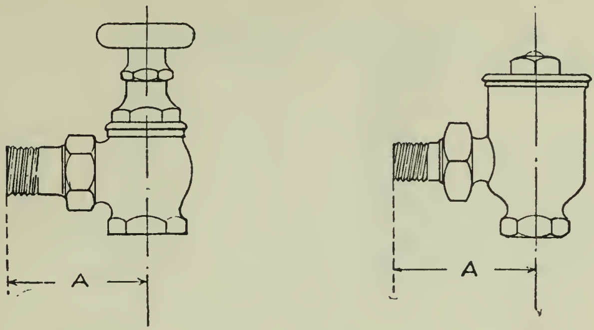


STANDARD ROUGHING-IN DIMENSIONS
Angle Type Valves

Size of Valve	Dimension A Steam and Hot-Water Angle Valves and Union Elbows Effective Jan. 1st, 1926	Dimension A Modulating Valves Effective Jan. 1st, 1926	Dimension A Return Line Vacuum Valves Effective Jan. 1st, 1925
½″	2¼″	2¾″	3¼″
¾″	2¾″	2¾″	
1″	3″	3″	
1¼″	3½″	3½″	
1½″	3¾″	3¾″	
2″	4¼″	4¼″	
Tolerance	±⅛″	±⅛″	

Connecting ends shall be threaded and gauged as to threading according to the American (Taper) Pipe Thread Standard, ASA No. B2—1919.

The standardization of the Roughing-in Dimensions of Angle Steam and Hot Water, and Modulating Radiator Valves was made possible by the cooperation of the Manufacturers Standardization Society of the Valves and Fittings Industry.

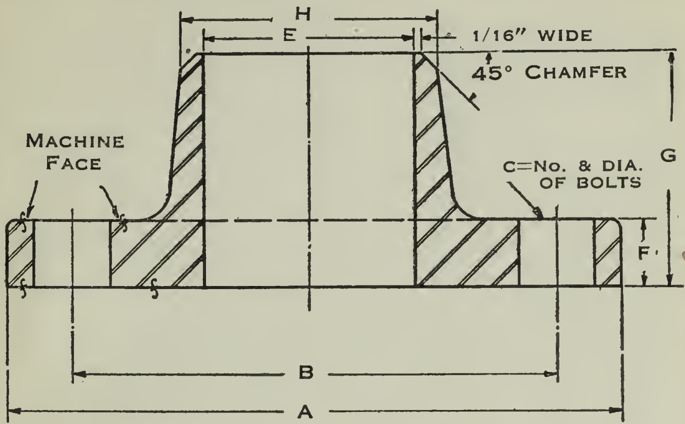


STANDARD ROUGHING-IN DIMENSIONS
Angle Type Valves

Size of Valve	Dimension A Steam and Hot-Water Angle Valves and Union Elbows Effective Jan. 1st, 1926	Dimension A Modulating Valves Effective Jan. 1st, 1926	Dimension A Return Line Vacuum Valves Effective Jan. 1st, 1925
½″	2¼″	2¾″	3¼″
¾″	2¾″	2¾″	
1″	3″	3″	
1¼″	3½″	3½″	
1½″	3¾″	3¾″	
2″	4¼″	4¼″	
Tolerance	±⅛″	±⅛″	

The standardization of the Roughing-in Dimensions of Angle Steam and Hot Water, and Modulating Radiator Valves was made possible by the cooperation of the Manufacturers Standardization Society of the Valves and Fittings Industry.

Issued November, 1925. Part IV, Page 1.

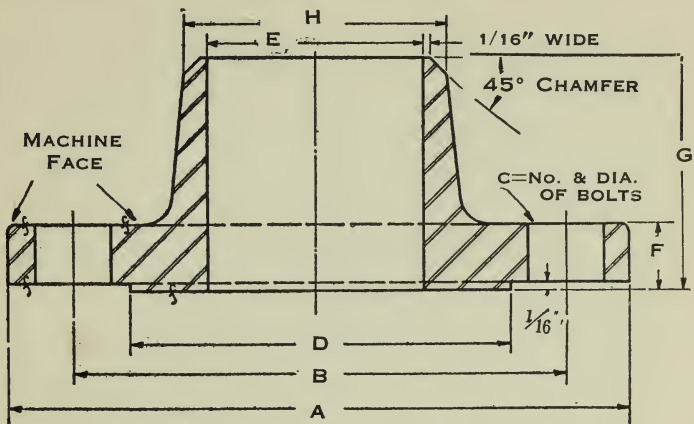


STANDARD WELDING NECK FLANGES FOR STANDARD PIPE—Series 15

Size	A	Drilling		E	F	G	H
		B	C	Std. Pipe			
2	6	4 3/4	4– 5/8	2 1/16	5/8	2 1/2	2 1/2
2 1/2	7	5 1/2	4– 5/8	2 15/32	11/16	2 3/4	3
3	7 1/2	6	4– 5/8	3 1/16	3/4	2 3/4	3 5/8
4	9	7 1/2	8– 5/8	4 1/32	15/16	3	4 5/8
5	10	8 1/2	8– 3/4	5 1/16	15/16	3 1/2	5 11/16
6	11	9 1/2	8– 3/4	6 1/16	1	3 1/2	6 3/4
8	13 1/2	11 3/4	8– 3/4	8	1 1/8	4	8 3/4
10	16	14 1/4	12– 7/8	10	1 3/16	4	10 7/8
12	19	17	12– 7/8	12	1 1/4	4 1/2	12 7/8
14 O.D.	21	18 3/4	12–1	*	1 3/8	5	14 3/16
16 O.D.	23 1/2	21 1/4	16–1	*	1 7/16	5	16 1/4
18 O.D.	25	22 3/4	16–1 1/8	*	1 9/16	5 1/2	18 1/4

*Orders or inquiries should specify diameter of bore "E" required.

Issued April, 1929. Part IV, Page 2

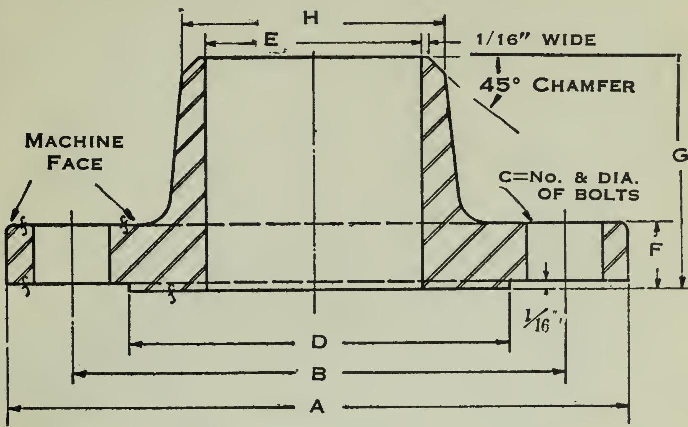


EXTRA HEAVY WELDING NECK FLANGES FOR STANDARD PIPE—Series 30

Size	A	Drilling		D	*E	F	G	H
		B	C					
2	6½	5	8– ⅝	3⅝	2 1/16	⅞	2¾	2½
2½	7½	5⅞	8– ¾	4⅛	2 15/32	1	3⅛	3
3	8¼	6⅝	8– ¾	5	3 1/16	1⅛	3⅛	3⅝
4	10	7⅞	8– ¾	6 3/16	4 1/32	1¼	3⅜	4⅝
5	11	9¼	8– ¾	7 5/16	5 1/16	1⅜	3⅞	5 11/16
6	12½	10⅝	12– ¾	8½	6 1/16	1 7/16	3⅞	6¾
8	15	13	12– ⅞	10⅝	8	1⅝	4⅝	8¾
10	17½	15¼	16–1	12¾	10	1⅞	4⅝	10⅞
12	20½	17¾	16–1⅛	15	12	2	5⅛	12⅞
14 O.D.	23	20¼	20–1⅛	16¼	*	2⅛	5¾	14 3/16
16 O.D.	25½	22½	20–1¼	18½	*	2¼	5¾	16¼
18 O.D.	28	24¾	24–1¼	21	*	2⅜	6¼	18¼

*Orders or inquiries should specify diameter of bore "E" required.

Issued April, 1929. Part IV, Page 4



EXTRA HEAVY WELDING NECK FLANGES FOR EXTRA HEAVY PIPE—Series 30

Size	A	Drilling		D	*E	F	G	H
		B	C					
2	6½	5	8– ⅝	3⅝	1¹⁵⁄₁₆	⅞	2¾	2½
2½	7½	5⅞	8– ¾	4⅛	2⁵⁄₁₆	1	3⅛	3
3	8¼	6⅝	8– ¾	5	2⅞	1⅛	3⅛	3⅝
4	10	7⅞	8– ¾	6³⁄₁₆	3¹³⁄₁₆	1¼	3⅜	4⅝
5	11	9¼	8– ¾	7⁵⁄₁₆	4¹³⁄₁₆	1⅜	3⅞	5¹¹⁄₁₆
6	12½	10⅝	12– ¾	8½	5¾	1⁷⁄₁₆	3⅞	6¾
8	15	13	12– ⅞	10⅝	7⅝	1⅝	4⅝	8¾
10	17½	15¼	16–1	12¾	9¾	1⅞	4⅝	10⅞
12	20½	17¾	16–1⅛	15	11¾	2	5⅛	12⅞
14 O.D.	23	20¼	20–1⅛	16¼	*	2⅛	5¾	14³⁄₁₆
16 O.D.	25½	22½	20–1¼	18½	*	2¼	5¾	16¼
18 O.D.	28	24¾	24–1¼	21	*	2⅜	6¼	18¼

*Orders or inquiries should specify diameter of bore "E" required.